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CHILDREN'S BELIEFS ABOUT

WHAT IT MEANS TO HAVE A MIND

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CHILDREN'S BELIEFS ABOUT

WHAT IT MEANS TO HAVE A MIND

by

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Dedication

This dissertation is dedicated to a number of people in my life without whom I would not be where I am today:

My grandmother (abuela): Maria Gil

My husband and life-long friend: David Chu

My mother, whose short time with me had a great impact: Mirtia Gil-Davis

My father: Howard K. Davis

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CHILDREN'S BELIEFS ABOUT

WHAT IT MEANS TO HAVE A MIND

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Children's understanding of the mind and mental states has been studied extensively by Theory of Mind researchers. Important aspects of understanding the mind involve general beliefs about what the mind is, what it can do, and what sort of entities have minds. In two studies I investigated the types of attributes children and adults believe an object or entity must have in order to claim that the object or entity has a mind. In Study 1, children and adults were asked about physical, mental and emotional characteristics of a number of entities, including intelligent artifacts (e.g., robots and computers), social entities (e.g., people and animals) and inanimate objects (e.g., flowers). They were also asked whether each of these entities is alive, and whether each has a mind, brain and heart. Adults were asked the same questions in the form of a questionnaire. Similarities and differences between how social entities, intelligent artifacts and inanimate objects are conceptualized were evaluated. Specifically, patterns of responses were analyzed to determine which characteristics are most strongly

associated with having a mind and a brain. The presence of a mind was most strongly associated with emotion, physical states, intentional behavior, advanced mental states, senses and sensations. The brain was most strongly associated with senses, sensations, physical states, intentional behavior, basic mental acts and advanced mental acts. In Study 2, children were presented with twelve unfamiliar "people, animals or things," each of which was presented as having between one and three mind-related characteristics (cognitive, emotional, and interactive). For example, they may have been told that a mippit can think (cognitive) and feel happy (emotional). Children were asked whether each entity is alive, and whether each has a mind, brain and heart. Patterns of responses were analyzed to determine which attributes are most strongly associated with having a mind and a brain. It was found that children consider cognition, emotion and interaction as indicators of the presence of a mind and brain

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INTRODUCTION

The nature of the human mind has long been a subject of philosophical discourse and psychological inquiry. Interest in the mind and its capabilities, however, has not been limited solely to the humanities and social sciences. The "mystery" of the mind has permeated the thoughts of humankind so much that it has become an important issue in a wide range of fields. Researchers in biology, artificial intelligence, human-computer interaction and other areas are increasingly focusing on issues related to the mind (see Scassellati, 2000, 2001; Bracken, 2000; Ramachandran & Blakeslee, 1998). It is not surprising that the nature of the mind generates so much interest in intellectual endeavors in so many different areas.

Both in the classroom and in the media, the mind is strongly associated with intellectual achievement and cognitive advancement. The ability to understand the driving force behind that achievement, and even trying to duplicate it, can be considered a motivating force in the advancement of our society. Fascination with understanding the mind, however, seems to go much deeper than this surface level advancement. The answers to questions about the nature of the mind are particularly significant in that they provide insight into people as humans, and mental beings. People are, after all, defined by the mind; what we do, what we think and how we perceive ourselves are intricately intertwined with our conception of the mind. Understanding of the mind is also critical to being able to function effectively in the world. Not only is a conception of the mind and its abilities used to successfully deal with other social beings, it is often used to help understand objects or entities that exhibit mind-like capabilities, such as computers. Whether or not a mind or mind-like properties are attributed to something (or someone) can have profound effects on how one interprets and interacts with that thing (Dennett, 1987). This is particularly true when making the distinction between having a mind and a brain. In Western culture, important moral, religious, and legal decisions revolve around whether an entity is believed to have a mind, as opposed to only a brain. For example, issues such as the timing and appropriateness of abortion and euthanasia rely upon people's perceptions of the entity in question. No one would argue whether a person in a coma has a brain, but whether that person has a mind is a more controversial matter that is more +central to the issue of euthanasia. The mind/brain question is also of import in other areas of people's lives. How should different types of entities be treated? Is an animal responsible for its own behavior? What about a highly advanced robot? Should these entities be punished for their misdeeds, and if so, what punishment is appropriate? These and similar questions underscore the need to have greater insight into how people view the mind and the brain.

Given the importance of our conception of the mind, it is not surprising that there is a considerable body of psychological research investigating the development of children's naïve understanding of the mind, or Theory of Mind (see Astington & Gopnik, 1991). Theory of Mind researchers have constructed comprehensive theories about the development of children's understanding of various mental states such as desires, beliefs, imagination and pretense (Flavell, 1988; Perner, 1991; Wellman, 1990; Woolley, 1995). Understanding of mental states is very pertinent to understanding of the mind, as the presence of mental state capabilities is often implicitly seen as synonymous with having a mind.

Although Theory of Mind research provides valuable information about understanding of the mind, its focus has been on children's understanding of specific mental states like desires and beliefs. However, understanding the mind also involves having more general beliefs about what the mind is, what it can do, and what sort of entities have minds. To date, there is not a comprehensive overview of development in children's and adults' conception of the mind itself. Part of the reason for this may be a lack of research on how the mind is viewed generally, aside from research on specific mental state understanding. To fill this gap, this paper asks three main questions: (1) What is known about children's and adults' conceptualization of the mind? (2) How does this understanding develop over time as children grow and technology changes? and (3) How do children and adults determine whether something has a mind?

Conceptualization of the Mind and Brain

To date, there has been very little research that has addressed children's and adults' generalized conceptualization of the mind. In a series of four experiments, Johnson and Wellman (1982) investigated generalized conceptions of the mind and brain. One study focused on a comparison of children's understanding of the mind and brain. In this study, 5- to 15-year-olds were asked questions about the nature of the mind and brain (e.g., where they are located, whether they can be seen or touched), whether or not an assortment of mental (think, remember), emotional (interested, happy), sensory (see, hear), motor (talk, walk) and involuntary (breathe, sneeze) acts could be performed without the brain and, separately, the mind, and whether the mind or brain could exist without the other. Results indicated that children conceptualize the brain and mind as separate entities. Whereas younger children only claimed that the mind and brain differ physically, older children claimed that the brain and mind differ both ontologically and functionally. Older children conceptualized the mind, unlike the brain, as intangible and invisible. They further distinguished the brain from the mind in that the brain was more frequently associated with bodily acts (e.g., walk, talk) whereas the mind was viewed as "reserved for more purely mental acts" (p. 229). Still, both the brain and mind were claimed to be responsible for mental acts and, increasingly with age, emotional acts. Finally, whereas younger children tended to view the mind and brain as independent from each other, older children tended to either view the mind and brain as interdependent or viewed the mind as dependent on the brain, but not vice-versa.

In the three remaining studies, Johnson and Wellman (1982) looked solely at children's and adults' conceptualization of the brain. Two of these studies investigated conceptions of the brain using a similar methodology to the study discussed above. The main difference between these two studies and the above study was that participants were asked whether certain activities required a brain (as opposed to whether those activities could be performed without a brain). Thus, in these two studies, 3- to 11-year-olds and adults were asked whether the brain is required for an assortment of mental and motor acts (all ages), and emotional, school, sensory, and involuntary acts (5-year-olds to adults). Five- to 11-year-olds were also asked questions about the nature of the brain (e.g., where it is located, what it does). Three-year-olds tended to exhibit very little knowledge of the functions of the brain, and responded to the mind/brain questions in an undifferentiated manner. By four years of age, children indicated that the brain was needed for mental acts. Children five years of age and older indicated that the brain was needed for emotional and school acts (e.g., spell, count, read). Claims that sensory and motor acts required a brain increased with age. Finally, only adults claimed that the brain was required for involuntary acts. It was concluded that 3-year-olds are ignorant of the functions of the brain. Whereas children as young as four view the brain as needed only for intellectual acts, older children have a more inclusive view of the brain in which non-mental acts are also considered to be controlled by the brain. Adults view the brain as needed for all types of acts.

In their last study, Johnson and Wellman (1982) investigated young children's understanding of the physical relation between the head and brain. Three- to 5-year-olds were asked whether the experimenter and a doll had a number of external facial features (e.g., eyes, head) and a brain, and whether these features were inside or outside of the body. Although 3-year-olds did not systematically confuse the head with the brain, they tended to claim that the doll possessed a brain. By four years of age, most children indicated that the brain was internally located and that the doll did not possess a brain.

The Johnson and Wellman (1982) studies provide a good launching point from which to further investigations into conceptualizations of the mind. They are, however, limited in some respects. Although one of the four studies compared the mind and brain, the bulk of the research only focused on conceptualizations of the brain. Yet important differences were found in conceptualizations of these two entities. This, combined with the finding that children tend to view the mind and brain as separate, argues for more research investigating conceptualization of the mind, as well as more detailed investigation into how the mind is seen as differing from the brain. In addition, although these studies addressed a good range of task categories, the number of categories used limited the number of specific tasks that could be investigated within each category. There may be other types of tasks, such as higher-level mental acts (e.g., problem solving) and complex emotions (e.g., pride), which may be more indicative of the presence of a mind.

Although there are no other empirical studies that directly address children's conception of the mind, additional insight can be gained by further examining research on children's understanding of the brain. Since Johnson and Wellman (1982) did find some similarities in attributional judgments of the mind and brain, it is a logical step to investigate children's understanding of the brain to determine other possible avenues of investigation into their conception of the mind.

Other studies investigating children's understanding of the brain have found similar results to Johnson and Wellman's (1982). Scaife and van Duuren (1995) and van Duuren and Scaife (1996) investigated children's and adults' judgments of brain and brain-related behavior of entities with differential anthropomorphic similarity (person, robot, computer, doll and book). Scaife and van Duuren (1995) asked 5- to 11-year-olds and adults whether each of the entities had a brain and heart, where the brain was located and what the brain was made of. At the end of the session, participants were again shown pictures of the entities and asked "Is there anything on the table which has a sort of brain even though it is different from ours in some way?" (p. 370). Whereas 5-year-olds tended to attribute a brain only to the person, older children and adults appeared to respond based upon cognitive features. Older children's and adults' most common pattern of response was to attribute a brain to the person, robot and computer.

In a subsequent study, van Duuren and Scaife (1996) asked 5- to 11-year-olds and adults to determine whether the entities could perform certain mental, emotional, school-based, simple motor, sensory and involuntary acts. Whereas 5-year-olds were more likely to make brain-related attributions based on perceptual cues (i.e., physical similarity to humans), older children and adults tended to make these determinations based on cognitive capabilities, autonomy and, sometimes, conceptual classification. Children also began to claim that the robot was able to perform brain-related behavior at slightly younger ages than when they made those same claims for computers. Overall it was concluded that older children and adults consider the computer and robot as more ambiguous than a person and doll when considering brain-related behavior. Finally, younger children were more likely than older children and adults to view intelligent artifacts (e.g., computer and robot) as not being able to perform brain-related behaviors.

The findings of Scaife and van Duuren (1995) and van Duuren and Scaife (1996) support and extend Johnson and Wellman's (1982) findings concerning children's and adults' conceptualization of the brain. In all these studies, children and adults were found to associate cognitive and mental acts with the brain, and younger children were found to be more limited in their brain understanding and brain-related attributions than older children and adults. However, the Scaife and van Duuren (1995) and van Duuren and Scaife (1996) studies provide more details about this understanding. Young children's understanding of the brain is not only more limited than that of older children and adults; young children also seem to be more rigid in the criteria used when making brain attributions. Unlike older children and adults, younger children had a tendency first to attribute a brain and brain-related behaviors solely to the more human-like intelligent entities, indicating that they tend to rely more on perceptual cues in making this determination. Older children and adults seem to make these attributions primarily based upon cognitive capabilities. Further, older children's and adults' conception of the brain seems to be more flexible in that they appear to indicate that there are different types of brains. When asked to include brains that are different from a human brain, the majority of older children and adults attributed a brain to the robot and computer in addition to the person (Scaife & van Duuren, 1995).

In addition to the question of what other mental capabilities children and adults might associate with the brain, there is still a question concerning the strength of children's association between cognitive capabilities and the brain. There are several different levels of understanding that children may have. It may be that children only hold a loose association between the brain and cognition, such that they are aware that cognitive capabilities are generally associated with the brain, but they are uncertain of exactly what that association is. Alternately, they may hold a strong association between the brain and cognitive capabilities in which they believe that a brain is necessary for cognitive capabilities. However, even if they possess a strong association between the brain and cognition, they may not understand certain implications of this. One important implication is that an individual's cognitive capabilities are bound to that individual's brain. In other words, individual characteristics, such as identity, cannot be separated from that individual's brain. Although the above studies investigated the more general association between the brain and cognitive capabilities, they did not investigate the strength of the association between the brain and individual psychological characteristics, such as identity.

IDENTITY AND THE BRAIN

This issue of the relation between the brain and a person's identity is particularly interesting. Philosophers have speculated that transplanting the brain would result in a transfer of the mind and self to the recipient of the transplant (Popper & Eccles, 1977). Children's and adults' claims about the results of a brain transplant could provide significant insight into not only children's and adults' beliefs about the relation between the brain and a person's identity, but also about how strongly children and adults believe the brain is tied to an individual's cognitive capabilities. If it is believed that the brain is strongly tied to individual capabilities, then when a brain transplant takes place, an individual's cognitive capabilities will also be transplanted. If, however, the brain is only generally associated with cognitive capabilities, but not strongly tied to individual characteristics, then an individual's cognitive capabilities would not be transferred to the brain transplant recipient. Given that young children seem to be in a transitional stage in gaining an adult-like understanding of the brain (Johnson, 1990), they may not yet have this understanding even though they generally understand the brain is required for certain cognitive acts.

Two studies have used the brain transplant methodology to investigate children's understanding of the brain. Johnson (1990) investigated aspects of children's understanding of the brain with regard to individual characteristics. In a series of four studies, 5- to 11-year-olds were told stories and asked questions designed to determine whether a brain, heart, mouth or face transplant would have an effect on an entity's identity, physical, cognitive and behavioral characteristics. Children were told a story about the preferences and capabilities of a pig, baby or child character. Following the story, children were told to imagine that their brain, heart, mouth or face was switched with or transplanted into the character's body. Children were asked about the characteristics of the character or themselves after these changes were made. For example, in the first study children were told a story about two pigs. These pigs were described as having characteristics such as liking being pigs and rolling around in the mud, and hating sleeping in a bed. After being told to imagine that their brain was transplanted into one of the pigs, children were asked whether the pig would look, act, feel or think differently, behave in certain ways (e.g., sleep in a bed or slop, have a child or pig for a friend, play with toys or in a pig pen, and have memories as pig or child) and have certain identity characteristics (e.g., identify itself as the pig or child, answer to the child's or pig's name, and claim it was a pig or person).

The results indicated that children consider the brain more central than the mouth, heart or face to someone's identity, cognitive and behavioral attributions. The brain also had a slight tendency to be more strongly associated with cognitive capabilities than behavioral or identity attributions. For example, children claimed that a brain transplant would result in changes in what the transplant recipient thinks, feels and acts, but not in the recipient's physical appearance. In contrast, a transplant of the mouth was claimed to change physical appearance, but not how the recipient thinks. Results also seemed to indicate that children's understanding of the brain is still developing in the early school-aged years. Unlike older children, younger children tended to respond in an undifferentiated manner in the cases in which there were not clear categorical differences between the donor and recipient. For example, when the recipient was a baby, even young children were able to determine that a brain transplant would not change any of the baby's physical characteristics. When the recipient was a child, however, young children indiscriminately claimed that the transplants changed irrelevant physical items in almost half of their responses. Johnson (1990) concluded that during the elementary school years, children are in a transitional period in which they are learning more concrete knowledge about the physical brain, and that this knowledge may provide a foundation for more abstract concepts such as the mind.

Johnson's (1990) findings extend the findings of previous studies on children's understanding of the brain. He found that older children, and to a lesser degree younger children, do associate the brain with an individual's identity, thoughts, feelings and actions. These studies, however, did not address the issue of how children's understanding of the relation between the brain and individual characteristics develops over time into a more adult-like understanding. To address this issue, Gottfried, Gelman and Shultz (1999) conducted a series of four studies using a brain transplant methodology similar to that used by Johnson (1990). Specifically, Gottfried et al. (1999) investigated the development of the "brain as container" metaphor. According to this model, the brain "contains" thoughts, ideas, memories and other mental products. Thus, a brain transplant would also transplant an individual's mental contents.

Four- to 9-year-olds and adults were told stories and asked questions designed to determine whether a brain (Studies 1 & 2), stomach (Study 3) and entire bodily internal content (Study 4) transplant would effect an animal's thoughts, memories, vocalizations (Study 1 only) or appearance. Participants were also asked questions about animals' capabilities if the brain were removed. The results indicated that whereas older children and adults tend to consistently use the "brain as container" metaphor when reasoning about internal transplants involving the brain, young children generally do not. Gottfried et al. (1999) concluded that although younger children do understand that there is a relation between the brain and mental content/capabilities, they do not seem to have fully developed the idea of the brain as "containing" mental products. This is consistent with Johnson's (1990) findings that although younger children understood that there is a relation between the brain and mental content, they had difficulty understanding that a brain transplant would also result in transplantation of an individual's identity, thoughts and beliefs.

Gottfried et al. (1999) also found that although children of all ages readily understood that an animal with a brain could perform mental acts such as thinking and remembering, fewer children correctly responded that an animal without a brain could not perform mental acts. Children's understanding of the relation between the lack of a brain and the inability to perform mental functions seemed to be directly related to their level of general knowledge about the brain. Children who had a greater knowledge of the brain were more likely to understand that an animal could not think or remember if it did not have a brain. Gottfried et al. (1999) concluded that children begin with an essentialist understanding of the brain in which animals act in certain ways because of their category membership. As children attend school and their understanding of biology increases, their understanding of the brain and its functions also increases. When children reach approximately 8 years of age, they are finally able to understand the significance of the role of the brain, and begin to consistently use the “brain as container” metaphor in an adult-like manner.

Although these studies provide a window into understanding conceptualizations of the mind, they are limited in that they primarily focus on conceptualizations of the brain. It is possible to infer some of how children and adults conceptualize the mind using their conceptualization of the brain, but this may not yield an entirely accurate account. Johnson and Wellman (1982) did find ontological and functional differences in judgments regarding the mind and brain. It is not only possible, but likely, that other differences in conceptualizations of the mind and brain exist. For example, mental acts may be more strongly associated with the mind than the brain, and certain other attributes may be more strongly associated with the brain than the mind. Alternately, it may be that certain types of mental acts (e.g., complex mental acts) are more strongly associated with the mind than are other types of mental acts (e.g., basic mental acts). Other types of acts and characteristics (such as volition, intention, animacy and a sense of self) that were not addressed in these studies may also be viewed as having a strong relation with the mind. Therefore, it is worthwhile to examine research in other areas that may contribute to understanding of children’s and adults’ conceptualization of the mind. Thus, the following section will focus on studies that find relations between various mental state capabilities and other attributes such as animacy, emotion and volition.

Conceptualization of the Mind- and Brain-Related Attributes

When thinking about the mind and mental state capabilities, two questions that can be posed are ‘Who (or what) has a mind?’ and “Who (or what) has mental state capabilities?’ Although there are no studies that directly address what types of entities people believe to have minds, there are a number that examine mental state attributions to a variety of different entities.

ATTRIBUTIONS OF MENTAL STATES AND LIFE

One relevant area of research is children's understanding of aliveness and animacy (Gelman & Spelke, 1981 ; Gelman & Opfer, in press) . The ability to determine what is alive is an important component of development and a necessary component of understanding the social world. After all, before more advanced technology came along, reciprocal and seemingly intentional interactions could only take place with other living beings. Within the animacy literature, there are a number of studies that have found relationships between specific mental states and characteristics of animacy. This can provide interesting clues to help uncover how people determine whether something has a mind.

One study in particular investigated the relation between mental state capabilities and the determination of whether something is alive. Nigam and Klahr (1999) investigated this relation by comparing children's beliefs about a number of different entities. Four- to 10-year-olds were presented with pictures of 7 different entities (person, monkey, robot, computer, doll, TV and hammer) and asked to determine whether these entities were alive and whether they could engage in various cognitive (e.g., thinks, has ideas, learns new things, makes mistakes and counts to 10), emotional (e.g., is happy, can get lonely) and volitional (e.g., makes choices, sometimes breaks the rules) acts.

Children of all ages were able to determine that the person and monkey were alive, but that the computer, doll, TV and hammer were not. An age trend was found in which, as children got older, they increasingly attributed cognitive mental states to biological kinds (person and monkey) and intelligent artifacts (robot and computer). A similar age trend was found in emotional state attributions to biological kinds, particularly for the monkey. However, for the robot and doll, attributions of emotion decreased with age. Volitional attributions dramatically increased with age for the person, monkey and robot, and moderately increased for the computer. Thus, although children were willing to attribute cognitive capabilities to both biological kinds and intelligent artifacts, they were less likely to attribute emotion and volition to entities that are not alive. Finally, a relation between mental state attribution and animacy was found in which high levels of cognitive, emotional and volitional attributions positively predicted animacy judgments. Volition was found to be the strongest predictor, followed by emotion.

Unlike previous studies, the Nigam and Klahr (1999) study provides insight into the relation between different types of mental state capabilities and children's conception of life. Nigam and Klahr found that cognition, emotion and volition can all be used to predict whether an entity is alive. However, they also found that children were willing to attribute cognitive capabilities to intelligent artifacts, which are not alive, whereas they were only willing to attribute emotion and volition to living biological entities. Thus, it seems that an entity that is alive can perform cognitive acts, but the presence of the ability to perform cognitive acts alone does not necessarily mean that the particular entity is alive. This is consistent with studies that investigate children's explanations of action, in which it has been found that children will provide mental explanations of action even if they indicate that the actor does not have a brain (Montgomery, 1994). This can provide clues into possible relations between these same types of mental states and the presence of a mind. As was stated previously, the presence of mental state capabilities, such as thinking, is often seen as being synonymous with having a mind. If children's and adult's attribution of the presence of a mind is similar to attributions of life, then the actual relation between mental states and the presence of the mind may be more complicated than a simple "thinking = mind" equation. As with cognitive capabilities and attribution of life, people may believe that the presence of a mind indicates that an entity can perform cognitive tasks, but the ability to perform cognitive tasks may not necessarily mean that a mind is present. On the other hand, there may be mental capabilities that people believe cannot be present without a mind. It was found that people claim that volition and emotion are only present in entities that are alive. Similarly, people may believe that volition and emotion are a critical component of the mind, and without a mind volition and emotion are not possible.

Further, people may believe that in order for a mind to be present, more exclusively "human-like" mental capabilities must also be present. . It has been theorized that young children use similarity-based comparisons to humans when making attribution judgments (Carey, 1985). In fact, studies have found that children, and sometimes adults, tend to use overall similarity to humans when making attributions of mental capabilities (Inagaki & Hatano, 1987; Inagaki & Hatano, 1999; Inagaki & Sugiyama, 1988; Montgomery, 1994). Emotion and volition are arguably more human-like capabilities than are certain cognitive abilities (see Rasmussen, et al., 1993). Nigam and Klahr (1999) found that volition and then emotion were the most predictive of the determination of life. Similarly, it may be that volition and emotion are more indicative of the presence of a mind than cognition.

Results from the Nigam and Klahr (1999) study can also provide some clues to development in children's attributions of a mind. They found that as children age, they are more likely to attribute cognitive, emotional and volitional acts to biological entities and, in certain cases, intelligent artifacts. This suggests a pattern in which younger children are more stringent in their attributions of mental states whereas older children tend to be more flexible. This would be consistent with Scaife and van Duuren's (1995) and van Duuren and Scaife's (1996) findings concerning brain attributions. They found that older children and adults were more flexible than younger children when attributing a brain to different types of entities. This may reflect a global tendency in younger children to be more stringent in their willingness to attribute more exclusive human-like capabilities. If this is the case, then it is likely that younger children would be less likely than older children and adults to attribute a mind to entities that are not human.

A number of studies have addressed people's attributions of mental states to non-human animals. Rasmussen et al. (1993) conducted two studies designed to investigate humans' implicit theories of the animal mind. College students and animal-behavior professionals were presented with a series of test scenarios in which they were asked to determine the reasonableness of a series of mental operations or experiences (sensation and perception, gratitude, emotion, pleasure and displeasure, object permanence, morality, schemata, enumeration and sorting, dreaming, playing and imagining, conservation, and memory and foresight) in which the character was either a fish, cat, dog, bird or child. For example, participants were asked how reasonable it would be that a fish could distinguish between small, medium and large cookies.

Overall, the results indicated that all participants credited both the child and animals with simple thinking capabilities (sensation and perception, gratitude, emotion, pleasure and displeasure, and play and imagination), but were more likely to attribute complex thinking (object permanence, morality, schemata, enumeration and sorting, dreaming, conservation, and memory and foresight) to the child. The attribution of complex thinking differed significantly between all characters, with the child being more capable of complex thinking, followed by the dog, cat, bird and fish, respectively. Simple thinking capabilities differed significantly between all characters except for between dogs and cats. The child was the most likely to be ascribed with simple thinking capabilities, followed by dogs and cats, birds and lastly, fish. A closer investigation of the specific mental capabilities found that all participants considered some capabilities simple for both the child and animals (sensation and perception, pleasure and displeasure, emotion, and gratitude). Other mental capabilities were considered complex for both the child and animals (conservation, memory and foresight, schemata, morality and object permanence). Three mental capabilities differed from these patterns. Play and imagination were considered complex for the child but simple in animals. However, enumeration and sorting, and dreams were seen as simple for the child, but complex in animals (Rasmussen et al., 1993).

In a subsequent study, Rasmussen and Rajecki (1995) further investigated human's implicit theories of the animal mind. Using a methodology similar to the Rasmussen et al. (1993) studies, Rasmussen and Rajecki (1995) asked college students to determine how reasonable it would be to say that a boy and, separately, a dog could perform a series of mental operations, and experience a number of guilt and shame related emotions. Their findings for the ability to perform mental operations were consistent with those of Rasmussen et al. (1993). Their results for the guilt/shame items showed a similar, although not exact, pattern of response as the mental operations. Although lower level guilt/shame items were accredited to both the boy and dog, upper level guilt/shame items were more likely to be attributed to the boy than to the dog.

Rasmussen et al.'s (1993) and Rasmussen and Rajecki's (1995) results are of particular interest because they provide an intricate view of lay people's attributions of mental states to a number of different types of entities. This intricate view shows that attributions of mental states are quite detailed and involve various levels of capabilities. First, people's beliefs about mental states involve more general, overall attributions of mental states to different types of entities (e.g., both humans and animals are capable of thinking about things). There is, however, a second process involved in mental state attributions in which individual attributions break down mental state capabilities into levels or degrees. Thus, although both humans and animals may be capable of thinking, humans are attributed with a more complex level of thinking capability than animals. Finally, these results also illustrate that these levels or degrees differ from one entity-mental state pair to another entity-mental state pair (i.e., it is not that humans are always capable of complex levels of mental states and animals are only capable of simple levels of mental states. It is that certain mental states may be complex in humans but others are simple, and the same can be said of animals.).

Although Rasmussen et al.'s (1993) and Rasmussen and Rajecki's (1995) studies provide a more detailed view of mental state attribution, there was no direct evaluation concerning the presence of a mind in the various entities (i.e., participants were never explicitly asked whether the various entities had minds). However, it is likely that people's reasoning about mind attribution is similar to that of mental state attributions. First, as with mental states, people's beliefs about who has a mind likely involve a general attribution of a mind to different types of entities. Thus, it may be that both humans and animals are typically attributed with having a mind even though detailed capabilities may differ. Second, individual attributions of a mind may break down into a structure similar to levels or degrees in mental states. In this case, however, it is probable that these levels or degrees are equivalent to the attribution of different kinds of minds (e.g., it may be that both humans and animals are attributed with a mind, but when examined in detail, it may be that they are attributed with minds that differ in some fundamental way). Finally, entity-kind of mind pairs are likely determined by the combinations of types and levels of mental state capabilities similar to the entity-mental state pairs. Thus, people may believe that children have one kind of mind because their imagination is complex but their dreams are simple, whereas dogs may have another kind of mind because their play is simple but their dreams are complex.

The more detailed view of mental state attribution provided by the Rasmussen et al. (1993) and Rasmussen and Rajecki (1995) studies also serves to illustrate a potential problem with extrapolating the relation between mental capabilities and life (from Nigam and Klahr, 1999) to the relation between these mental capabilities and the presence of a mind. It could be argued that the exemplars for each of the mental acts that the Nigam and Klahr (1999) study used only reflect simple levels of these capabilities. For example, stating that an entity can think could be considered a lower-level cognitive task whereas solving a word problem could be considered a higher-level cognitive task. As the Rasmussen et al. (1993) and Rasmussen and Rajecki (1995) studies seem to indicate that adults break down attribution of mental state capabilities into levels or degrees, it seems likely that this might also be the case with older children. Further, this would also possibly indicate that lower-level and higher-level mental state capabilities might have different relations with attributions of life or the presence of a mind. Thus, it may be that although lower-level cognitive acts do not necessarily indicate the presence of a mind, higher-level cognitive acts may.

Rasmussen et al. (1993) and Rasmussen and Rajecki (1995) provide valuable insights into adult's views about how mental state capabilities in animals compare to mental state capabilities of human children. However, their studies are limited in that (1) they only use two general types of entities (a child and animals), (2) their studies only involve adult participants, and (3) they do not directly address understanding of specific concepts (e.g., emotion) but instead focus on beliefs regarding the capabilities of certain entities. Therefore, clues to how other types of entities are viewed, how these beliefs develop in children, and specific information about how these concepts relate to each other must be sought from other areas.

TWO KEY MENTAL STATES

The Importance of Volition

One mental state that seems to be of particular importance is volition, or the capability to control oneself. Nigam and Klahr (1999) found that of the three types of mental states that they investigated, volition was most predictive of life attribution. As volition can also be regarded as a higher-level, more human-like mental state, and the human mind can be considered the best characterization of what a mind is, it seems likely that volition will be the one of the most predictive of the mental states in determining the presence of a mind. Volition is also considered one of the attributes of animacy. Gelman (1990) states that the development of the concepts of animate and inanimate objects is "guided by principled concern for whether objects move on their own or not" (p. 91). Gelman and Spelke (1981) suggest that animates, unlike inanimates, can act on their own (i.e., have volition) and have mental states and mental representations. They further posit that because children claim that inanimate objects, such as dolls, lack brains and mental capabilities, they likely also believe that inanimates lack minds. Therefore, a closer investigation of understanding of volition may provide additional clues to what it takes to have a mind. Unfortunately, there is not any research that directly addresses the relation between volition and the presence of a mind. There is, however, quite a bit of research on children's understanding of the relation between different types of movement and life attributions.

Previous studies have found that both children and adults often view movement as an indication of life (Carey, 1985; Gelman, 1990; Massey & Gelman, 1988; Piaget, 1973;

Richards & Siegler, 1984; Richards & Siegler, 1986). However, studies have also found that movement alone or just any type of movement is not sufficient to make the determination of life. In a series of three studies, Richards and Siegler (1986) investigated children's and adults understanding of the attributes of life. In Study 1, 4- to 11-year-olds and adults were asked to name attributes of living things. For children of all ages, movement was the most often cited attribute of life. Movement was also considered significant by adults, and was the fifth most commonly cited attribute of life. Study 2 investigated how children and adults determine whether an unfamiliar object is alive. To do so, six important attributes of life were studied: two that are considered defining features (growth and reproduction), two that are considered sufficient but not necessary characteristics (vision and [plant] rootedness) and two that are characteristics, but neither necessary nor sufficient (movement and making noise). Children and adults were presented with a scenario in which they were asked to determine whether a series of unfamiliar objects that were found on an alien planet were alive. Each unfamiliar object was described as having and/or not having two of the six attributes described above. At all ages, objects described as having defining features were more likely to be attributed with life than those with only characteristic features. Results also indicated that as children got older, they were more likely to attribute life to objects that had defining features. Interestingly, however, movement was still considered an important indication of life even though it is not a defining feature. For all age groups, movement received one of the three highest life attribution scores. This finding was contrary to what was expected. Richards and Siegler had hypothesized that all of the characteristic features (roots, vision, movement and noise-making) would be weak indicators of life. This was clearly not the case for movement.

To try to better understand the relation between life and motion, Study 3 investigated how strongly children associate different types of motion with life. Five- to 11-year-olds were shown videos depicting movement that varied along four dimensions: spontaneity (object is pushed into moving vs. begins moving by itself), goal-directedness (object approaches a truck vs. approaches nothing), type of movement apparatus (object moves via legs, wheels, or no appendages) and type of terrain (object moves down a hill vs. across a flat surface). After each scenario, children were asked to indicate whether the object in the video was alive. Results indicated that objects that initiated movement by themselves (i.e., a form of volition) were judged to be alive whereas those that were pushed were judged to not be alive.[1] The youngest children (5- and 6-year-olds) only associated life with the type of movement apparatus when the apparatus was legs. As with the youngest children, the older children (7- to 10-year-olds) tended to attribute life to objects that moved on leg-like appendages. However, unlike the youngest children, the older children also relied heavily on spontaneity in making life attributions. Richards and Siegler (1986) concluded that children do differentiate different types of motion, and that these different types of motion strongly influence children's attributions of life. They further concluded that children are willing to attribute life based on the types of movement engaged in by animals, but not that of inanimate objects.

Other studies have found results similar to Richards and Siegler (1986), indicating that both children and adults consider intentional movement an indication of life (Massey & Gelman, 1988; Richards & Siegler, 1984). The results from Richards and Siegler (1986), however, help provide further understanding of a possible overall pattern concerning how children reason about social beings. The pattern of findings that children

[1] It should be noted that goal-directed motion was eliminated from the analyses as the researchers were unable to determine whether children viewed the scenario with the truck as depicting goal-oriented behavior.

are willing to attribute life to entities that exhibit the type of movement engaged in by animals is similar to findings on children's attributions of a brain. Just as 5- and 6-year-olds were more rigid in their brain attributions than older children (Scaife & van Duuren, 1995; van Duuren and Scaife, 1996), younger children were also more rigid than older children in their attributions of life based on movement. Whereas older children and adults were willing to attribute life based on two of the dimensions presented in the Richards and Siegler (1986) study, younger children were only willing to attribute life based on one of those dimensions.

The cues used for attribution of these two characteristics also appear to be strikingly similar. First, in the Scaife and van Duuren (1995) and van Duuren and Scaife (1996) studies, younger children seemed to be basing their attributions of a brain on perceptual similarity to people. This also seems to be true in the Richards and Siegler (1986) study. Younger children were only willing to make attributions of life for the entity that was most perceptually similar to humans--the entity that used legs for movement. This, combined with Nigam and Klahr's (1999) findings that as children get older they increasingly attribute cognitive, emotional and volitional acts to biological entities, can be interpreted as providing additional evidence for the existence of a global tendency for young children to be more reluctant than older children to attribute human-like capabilities.

Second, unlike younger children, older children's attributions of both life and a brain were strongly based on indications of mental capabilities, including indications of volition. In the Richards and Siegler (1986) study, older children were found to attribute life to entities exhibiting self-initiated movement. Older children in the Johnson and Wellman (1982) study indicated that in order to perform voluntary overt acts, a brain must be present. . Intentional behavior such as self-initiated movement and voluntary overt acts can be defined as forms of volition. This, however, does not necessarily mean that children and adults are interpreting these types of behavior as volition, or even seeing these as resulting from internal mental states. A number of studies have been done addressing precisely this question. Specifically, these studies have investigated how children and adults interpret intentional action.

Intentional Action

Montgomery (1994) conducted a series of studies investigating what types of situations influence children's explanations of action. In Study 1, preschoolers, first graders and adults were asked to determine whether the actions of humans, mammals, insects or artifacts were caused by mental or physical states when three situational features were present (self-initiated action, variable action and perception of the critical fact or event underlying the action). Participants were presented with 16 descriptions of actions in which the situation features were present and 5 in which these features were not. For each action, participants were asked to indicate why the actor was performing those actions. They were then asked whether artifacts such as cars and trains have brains, can think, and feel happy and sad. Results indicated that when actions were accompanied by the three situational features, children of all ages consistently chose mental explanations for those actions regardless of the type of actor. Adults tended to limit their mental explanations to actions performed by humans and mammals. When the three situational features were not present, preschoolers were more likely to provide a mental explanation for the action when the actor was animate, but more likely to provide a physical explanation when the actor was inanimate. Older children and adults, however, were equally likely to give physical and mental explanations of the actions regardless of the type of actor. Nevertheless, participants of all ages provided significantly more mental explanations for actions when the three situational features were present than when they were not. Results also indicated that similarity to humans also affects mental explanations of actions. Adults were more likely to provide a mental explanation for an action when the actor was more similar to a human, as were children, when the situational features were not present. In sum,Montgomery's findings indicate that both the three situational features and the type of actor contribute to mental explanations of actions.

In Study 2, Montgomery (1994) further investigated the importance of situational features. The focus of this study was to determine the unique influences of self-initiated movement and movement in which perception of the critical fact or event underlying the action is present. Preschoolers and first graders were presented with descriptions of actions in which (1) the action was caused by an external physical force, (2) the action was self-initiated, (3) a key event underlying the action was not viewed by the character in the description, or (4) a key event underlying the action was viewed by the character in the description. Following each description, children were asked to provide an explanation for the action. The results indicated that when actions were either self-initiated or a key event was viewed by the character, children tended to give mental explanations for the actions. Similarly, when the actions were either caused by an external force or a key event was not viewed by the character, children typically did not give mental explanations for the actions. It was concluded that children do abstract explanations for action based on situational features, and that the situational features do help determine what types of explanations are used to explain different types of actions. Further, children tend to provide mental explanations for actions that are self-initiated or in which critical information underlying the action is present regardless of how many other perceptual features are present.

Montgomery's (1994) findings provide direct evidence for the crucial link between intentional movement and animacy—imputing mental states. These findings, however, can also provide additional insight into what children and adults are doing in general when they witness events. As stated previously, Montgomery found that children provide mental explanations for action when one of two types of situational features is present: intentional action or perceptual access to key information underlying the action. Richards and Siegler (1986) found that intentional movement or having human-like appendages (i.e., legs) to enable movement resulted in children claiming that the actor was alive. Although these findings may have been somewhat disparate, there is one explanation that could explain all of them. All of these situations provide evidence that can lead to the conclusion that the actor in these cases is most likely capable of volition. After all, one could not intentionally perform an action without control over oneself. This, of course, is precisely the type of action portrayed in Montgomery's (1994) and Richards and Siegler's (1986) studies. Montgomery's (1994) other findings that when perceptual access to key information underlying the action is present, children provide mental explanations for that action, can also be interpreted as imputing volition to the actor. In Montgomery's second study, all of the actors were human. Volition is an important part of being human, and this, combined with a possible causal explanation for the action, is most likely why children gave mental explanations for these types of actions. This connection to humans can also explain Richards and Siegler's (1986) results that children will claim that actors that have legs that are used for motion are alive. Of all of the different entities presented to children in Richards and Siegler's study, the only one that had any perceptual similarity to a human was the square (actor) that had legs to move with. As there was very little other perceptual information available, children may have used this to determine that the entity was likely similar in that way to humans, or at least animates. This, in turn, may have caused them to impute volition to the entity based on the probable category membership as human or animate.

There is, however, evidence that children do indeed use category membership to make these types of judgments. Massey and Gelman (1988) presented 3- and 4-year-olds with pictures of unfamiliar objects that fell into one of five categories: mammals, non-mammalian animals, statues with animal-like forms, wheeled vehicles or multipart-rigid objects. Children were asked to indicate if each object could go up a hill by itself, or go down a hill by itself, and whether each was an animal, was alive and why (how they could tell). Children of all ages were able to correctly indicate whether each object could go up and down a hill by itself based on its category membership. Further, when asked to explain the reason for their judgments, category membership was the most commonly cited. This is not surprising. In general, children and adults tend to provide mental explanations for human behavior, whereas they tend to provide physical explanations for the behavior of inanimate objects (Wellman, Hickling and Schultz, 1997).

The Importance of Emotion

Nigam and Klahr's (1999) findings indicated that emotion was second only to volition in its predictive value for determining whether something is alive. This is significant in terms of discovering what children find are the most important aspects of life in general, as well as what makes human beings unique. In this age of technology, people are surrounded by objects that are not alive yet seemingly possess mental states such as thinking and some forms of problem solving. It would make sense, then, that these cognitive capabilities would not be as predictive of life as more uniquely human capabilities such as emotion. Unfortunately, there is no empirical evidence investigating this process, but through the use of clinical-type interviews, structured tasks and natural observation, Turkle (1984, 1991, 1998, 2000a, 200b) has made some interesting conclusions about the importance of emotion.

It has been proposed that when reasoning about the world, children most often compare humans with humanity's "closest neighbors" to establish what makes people uniquely human as well as whether something is alive (Turkle, 1984; Turkle, 1991). Turkle suggests that before modern technology became part of our everyday life, humanity's closest neighbors were animals. In comparing humans with animals, both children and adults could refer to cognitive capabilities in determining what made humans different, and biological and psychological similarities when determining what is alive. According to Turkle (1984, 1991, 1998, 2000a, 200b), however, this is no longer the case. Turkle claims that computers have replaced animals as humanity's closest neighbors. After all, computers arguably have cognitive capabilities closer to humans than animals do. With the advent of computers and computational toys, Turkle believes that children and adults have had to rethink what determines whether something is alive as well as what makes people uniquely human. In her research, Turkle's main finding has been that when discussing what is alive, children tend to focus on physical aspects of objects. With computers, however, they focus on psychological properties, just as they would with humans. Computational objects, it seems, are treated as psychological beings, not as objects. This persists even after children have participated in discussions about the role of biological properties in life.

Turkle reports that between the ages of 4 and 12, the discussion of the aliveness of computers seems to increase and become more sophisticated. Further, experience with computers tends to increase the use of psychological discourse when discussing whether computers are alive or not. In children's justifications about whether computational objects are alive or not, emotion is cited as the key factor in this determination. When comparing computational objects to humans and reasoning about whether they are alive, children often refer to those psychological qualities that humans have but that computers don't. Hence, children tend to focus on emotion. Humans can experience emotions. Computational objects, regardless of their cognitive sophistication, cannot.

So, what has been the effect of having computers as humanity's nearest neighbors on children's concept of life? It seems that what is considered alive has changed. Specifically, it is not that being biologically alive has been redefined. Instead, a new type or category of life has emerged that is different from the traditional definition of what it means to be alive. Turkle has found that many children have formed a new category of aliveness, that of being "sort of alive". This could, in some respects, be described as artificial life—being alive, yet not really alive like humans are. Children's views about what is alive are a reflection of the quality of their interactions with different objects. When children form a social relationship with computers by interacting with them, having emotional reactions to them and treating them as if they were alive, this may feel like evidence that they are alive. Yet, computers do not fit the definition of what is traditionally biologically alive. So, what differentiates really being alive and "sort of alive" may be the presence of emotion.

A parallel may exist in terms of determining whether something has a mind. According to Turkle (1984), the computer is treated as a psychological entity in "ways in which it seems or does not seem to be like a human being in the qualities of its mind" (p. 46). Thus, just as children seem to have created a new form of what it means to be alive, it seems likely that for computational objects, they may create a new type of mind. It may not be what is traditionally considered a mind, such as a human or animal mind, but perhaps an artificial mind. As with artificial life, it may be that emotion is the major determinant of what is a real mind and what is an artificial mind. Given this possibility, it is also important to consider the potential repercussions this may have when investigating children's and adult's beliefs about the nature of the mind. The most straightforward way of investigating whether children and adults believe that a particular object or entity has a mind is simply to ask them directly (e.g., does X have a mind?). If children believe there are different kinds of minds, however, one must use caution when drawing conclusions using this methodology. It is unclear whether, in answering this question, children and adults would focus on the most prototypical, or human-like, mind, or whether they would consider both real and artificial types of minds. This is an area that needs to be investigated, as the questions of interest include what types of mind are considered in various situations, as well as determining what additional types of cues (if any) would lead children and adults to consider other possibly less prototypical types of minds.

Turkle's (1984, 1991, 1998, 2000a, 200b) research helps discern the importance of emotion in children's judgments about the determination of life. However, her conclusions do need to be treated with some caution. Turkle's main method of gaining insight into children's conceptualization of computational objects involves clinical-type interviews. Although this type of methodology is useful in that it is typically open-ended, allowing the researcher to gain added detail when interviewing participants, it tends to lack a systematic quality that is needed to make concrete, verifiable conclusions. Still, the insight Turkle's methods have provided are useful stepping stones towards the creation of more concrete, verifiable research methods to investigate these particular questions.

The importance of emotion in determining what is and is not alive, and what does and does not have a mind is also reflected in Human-Computer Interaction literature. Within that research, one focus has been on the creation of "believable entities." These are entities that have characteristics that provide the illusion of life and allow users to suspend their disbelief that these entities are not real (Bumby & Dautenhahn, 2001). Some researchers claim that in order to have a believable entity, emotion must be an integral part of its design. Bates (1994) claims that emotion is “one of the primary means to achieve this believability, this illusion of life” (p.124). He further suggests that creators of believable entities use the three key points about believable entities proposed by Disney animators, that: (1) the emotional state of the entity should be clearly defined, (2) the entity’s thought processes should reveal the emotion, and (3) the emotion should be accentuated in a time-sensitive manner. Grand (2000) also encourages the inclusion of emotion in believable entities, as well as intelligence and a certain level of self-motivation.

COMPUTERS AND ROBOTS AS SOCIAL ACTORS

A final area that can be probed to gain clues about people’s conceptualization of the mind is how humans interact with computers and robots. As with many of the other areas of interest that have been discussed in this paper, there are no studies that directly investigate relations between conceptions of the mind and human interaction with computers or robots. However, research into people’s interactions with intelligent entities may provide some insight into how this may affect people’s conceptualization of the mind.

Research has found that both children and adults tend to treat computers as social entities (Turkle, 1984, 1991, 1998, 2000a, 200b) even though they are aware that those types of responses are inappropriate (Bracken, 2000; Nass, Steuer, Henrikson & Dryer, 1994; Nass, Steuer & Tauber, 1994). In a series of five studies, Nass et al. (1994) presented undergraduates with computer programs designed to appear to be a tutoring system. Participants were told that they would proceed through three sections, tutoring, testing and evaluation. Following the evaluation session, participants were asked to complete a questionnaire on their attitudes about the three sessions. Overall, results indicated that adults tend to treat computers as social entities and variation in the characteristics the computers portray affects how the computers are viewed. Social norms were found to be applied to computers, as were the notions of self and other. For example, although participants claimed that norms of politeness were not applicable to interactions with computers, participants consistently provided more praise in their follow-up questionnaires when those questionnaires were completed on the same computer they had worked on than when the questionnaires were administered either using paper and pencil, or on a different computer. This pattern of behavior is similar to that found when parallel interactions take place between social actors. In addition, different voices coming from computers tended to be treated as individual social actors, even if the voices came from the same computer. For example, participants tended to claim that praise given by a voice different from that used during the tutorial series was more positive, friendlier and more accurate. Again, this is that same pattern that would be expected if the participants had engaged in parallel interactions with social actors. Finally, adults were found to automatically and unconsciously respond socially to computers, and computer users viewed social interaction as being with the computer itself, not with the programmer.

Other studies have found similar results. Bracken (2000) investigated children's interactions with computers. Similar to Nass et al. (1994), Bracken (2000) used computer tasks and praise to gauge participants' attitudes towards the computers. She found that children, like adults, react to computers as if they are social entities. Scheibe and Erwin (1979) investigated adult's reactions to computers when playing computer games of varying intelligence. They recorded and analyzed participant's verbalizations while engaged in playing these games. They found that participants tended to personify the computer through use of personal pronouns. Further, they found that the greater the level of intelligence of the computer game, the more likely personal pronouns would be used to personify the computer. Hyson (1985) investigated the emotional effects of computer use in children. Five-year-olds were videotaped while using a computer drawing program, face construction program and counting program. They found that all three types of programs elicited positive, active and complex facial expressions in the children. The drawing program in particular tended to elicit high levels of social engagement. It was concluded that the motivational value of the emotion elicited during this computer use and the autonomy and control it allowed children were the primary reasons for the positive affect experienced when interacting with the computer.

Some researchers even claim that interactions with computers increase people's understanding of the mental world. Fletcher-Flinn and Suddendorf (1996) conducted a study investigating the effects of computer use on children's development of metacognitive abilities. Preschool children were given a battery of tests measuring mental age, source memory, false-belief understanding, and the ability to disassociate from the present and predict future knowledge. They were also observed during play. The amount and level of social play as well as the frequency of play with typical toys was recorded. The children's parents were asked to complete a survey asking about whether there was a computer in the home, availability of a computer at home or elsewhere, and the frequency of computer use by the child. A significant positive relation was found between computer use and metacognition. Fletcher-Flinn and Suddendorf concluded that computer use helps children's understanding of the mental world because the social interaction involved encourages children to take an explicit and observable intentional stance with computers, and aids children in developing representational abilities. As fascinating as Fletcher-Flinn and Suddendorf's conclusions are, they do need to be considered with some hesitation. Their conclusions suggest causal relations between computer use and metacognitive understanding, yet their analyses are correlational. Although there may be a causal relation, further studies would need to be done to confirm it.

THE CURRENT STUDIES

People's conceptualization of the mind is relevant to many different fields of research. To truly understand people's conceptualization of the mind, three general areas should be investigated: (1) How children and adults conceptualize the general nature of the mind and its capabilities, (2) how this understanding develops over time as children grow and technology changes, and (3) how children and adults determine what has a mind. The current studies were designed to provide some insight into these questions. Specifically, these studies were designed to help determine what types of attributes children and adults will claim an object or entity must have in order to claim the object or entity has a mind.

The first study employs the use of intelligent artifacts (e.g., robot and computer) to determine the relation between various attributes and the presence of a mind. Intelligent artifacts are particularly useful for this type of inquiry because of their ambiguous nature (Gelman, 1988; Keil, 1989); they are man-made artifacts yet they exhibit characteristics common to social beings and natural kinds (Turkle, 1984; Nigam & Klahr, 1999). Previous studies investigating understanding of the brain (Scaife & van Duuren, 1995; van Duuren & Scaife, 1996) and attributes of life (Nigam & Klahr, 1999) have used intelligent artifacts to investigate their questions of interest. A similar but more encompassing methodology was used in Study 1 to investigate understanding of the mind.

Pilot Study 1

METHOD

Participants

Participants were 13 younger children (4;4 - 7;0, *M* = 5;5), 12 older children (7;9 - 11;20,*M* = 10;8), and 18 adults (ages 34 - 54, *M*= 42). Adult participants were the parents of the children who participated. Participants were predominantly middle-class and Caucasian, but various ethnic groups were represented.

Materials

Materials consisted of 11 laminated 4x4 inch pictures of people (adult, child and baby), animals (parrot, cat and fish), intelligent artifacts (robot and computer), and inanimate objects (rock, TV and flower), and two boxes, one marked with the word "can" and the other with the words "can not."

Procedure

Children were interviewed individually at the Children's Research Lab. Children were asked questions and given sorting tasks aimed at determining which attributes children associate with different types of people (adult, child and baby), animals (parrot, cat and fish), intelligent artifacts (robot and computer) and inanimate objects (rock, TV and flower). The attributes used reflect various types of capabilities and characteristics (see Table 1), and were chosen based on attributes used in previous studies investigating the brain and attribution of life (Johnson, 1990; Johnson & Wellman, 1982; Nigam &

Klahr, 1999; Rasmussen et. Al, 1993; Rasmussen & Rajecki, 1995; Scaife & van Duuren, 1995; van Duuren & Schaife, 1996).

Table 1. Attributes used in Study 1 organized by attribute type.

Type of Attribute	Attributes Used
Emotion	Feel happy, Feel proud
Senses	See things, Say things
Sensations	Feel hot in a hot room, Feel hurt if they fall on the floor
Intentional behavior	Do something just because they want to, Sometimes be naughty
Physical states	Go to sleep, Get sick
Mental Acts	Think about something, Play a game, Remember a phone number, Remember what happened yesterday, Want something, Pretend to be something
Which ones…	have a Mind, have a Brain, are Alive
Sense of Self	Know what one is (e.g., a baby knows that it's a baby)

Warm-up Task. Children were first given a warm-up task consisting of 4 sets of questions. In each of these sets, children were asked where certain body parts (foot, heart, brain and mind) are and what can be done with them. Children were also asked whether they can see or touch the brain and mind. The purpose of using the foot and heart questions was so that children would have been asked about body parts that both can and cannot be seen before being asked about the brain and mind. Questions were grouped by body part, and the foot and heart questions were always asked first. Questions asking about the brain and mind were the third and fourth questions, and were counterbalanced between subjects.

Sorting Task. Children were then given a sorting task. Children were first shown a series of 11 pictures of different types of people, animals, and things (see above) and asked what the pictures depicted. The purpose of this was to ensure that the children recognized the entities and objects in the pictures. Children were then shown two boxes (Can, Can Not), and told that they would be asked to answer some questions by sorting the pictures into the boxes. Specifically, they were told that those that could do what they are asked about should be put in the Can box and those that could not do what they are asked about should be put in the Can Not box. A practice question was then asked: "Which ones can walk all by themselves?" The experimenter sorted the adult and rock pictures, and the children were asked to sort the child, cat, fish and flower pictures.

Children were then asked ten "Which ones can [attribute]?" questions and told to sort the pictures in the Can and Can Not boxes as described above. These first ten attributes were randomly taken from the list of attributes found in Table 1. Following these sorting tasks, children were asked self-knowledge questions about each of the pictures. For example, children were asked whether children know that they are children. Children were then given nine additional sorting tasks using the remaining attributes found in Table 1. Finally, children were asked whether they believed that the mind and brain are the same thing or different things. The protocol and response form for Pilot Study 1 can be found in Appendix A.

A questionnaire was given to parents when they brought their child into the lab. This questionnaire primarily assessed parents' beliefs about the same attributes and kinds of entities that the children were questioned about. Parents were asked to fill out the questionnaire either before (preferable if they wished to watch their children participate) or during their child's participation. The parent questionnaire for Pilot Study 1 can be found in Appendix B.

Pilot Data Results

Participants of all ages attributed significantly fewer characteristics to intelligent artifacts than to people or animals, but attributed more characteristics to intelligent artifacts than to inanimate objects. Participants' patterns of response were analyzed by averaging their scores across entities for each attribute type, and then using correlations to determine which characteristics are most associated with having a mind and brain. There was very little variation in grown-up, child, rock, and TV entity scores. Therefore, the analyses were restricted to the parrot, cat, fish, flower, robot and computer entities. Overall, the ability to perform mental acts (r =.65, $p < .001$) and engage in intentional behavior (r =.51, $p < .001$) were found to be most strongly correlated with the presence of a mind, followed by the ability to experience emotion (r =.35, $p < .05$) and sensations (r =.30, $p < .05$). The presence of a brain was found to be most strongly correlated with intentional behavior (r =.48, p =.01), followed by the presence of senses (r =.35, $p < .05$) and the ability to perform mental acts (r =.32, $p < .05$).

Age differences were also found. Children's responses, but not adults', exhibited an influence of anthropomorphic qualities. Children were significantly more likely to attribute the robot than the computer with experiencing emotion ($F(2,40) = 6.59$, $p < .01$), senses ($F(2,40) = 12.72$, $p < .001$), intentional behavior ($F(2,40) = 7.27$, $p < .01$), and mental acts ($F(2,40) = 8.47$, $p < .001$). Younger children ($M = .23$) were more likely than adults ($M = 0$) to attribute a mind to a robot (p =.05).

Pilot Data Conclusions

(1) Previous research has found that robots and computers are generally seen as lying along a continuum in which they are viewed as different from both inanimate objects and social beings in terms of the presence of a brain and brain-like capabilities. I additionally found that when attributing a mind and mind-like capabilities, people also

view intelligent artifacts as different from both animate entities and inanimate entities. Thus, intelligent artifacts are not viewed as entirely inanimate objects or social beings. This provides further support for the assertion that people view intelligent artifacts as having their own separate category (i.e., they are not viewed as merely inanimates with some special abilities, but instead are something distinctively in-between animate and inanimate entities).

(2) Although people view the mind and brain as having overlapping capabilities, there are differences in which attributes indicate the presence of a mind and a brain. Results indicate that the ability to perform mental acts and engage in intentional behavior are both associated with the presence of a mind and a brain. However, whereas mental acts and intentional behavior were found to have strong associations with the presence of a mind, the ability to perform mental acts was found to only have a moderate relation with the presence of a brain. Further, whereas sensations were moderately associated with the presence of a mind, sensations were not found to be significantly related to the presence of a brain. Finally, whereas senses were moderately associated with the presence of a brain, senses were not found to be significantly related to the presence of a mind.

(3) Children and adults focus on different criteria when making attributions of the presence of a mind and mind-like capabilities. Similar to previous studies, children were more likely than adults to rely upon anthropomorphic similarity to humans when making attributions of certain mind-like capabilities. Younger children, but not older children, were more likely than adults to attribute a mind to the robot than to the computer. Unlike previous studies, however, older children also relied upon anthropomorphic similarity for certain attributions. Children of all ages were found to be

more likely to accredit the robot than computer with experiencing emotion, senses, intentional behavior, and mental acts.

Suggested Changes

Piloting of Study 1 did not reveal any unexpected methodological concerns. Participation time in the study was typically under 15 minutes, even for the youngest participants (5-year-olds). None of the participants had any difficulty completing the tasks or answering the questions. The data analyses, however, revealed that responses to the adult and child questions were identical. Therefore, the child item/entity was not included in the list of entities used in Study 1.

Study 1

METHOD

Participants

Participants were 75 children, 26 5-year-olds (4;4 – 5;11, *M* = 5;6, 10 males, 16 females), 24 8-year-olds (7;9 – 8;11, *M* = 8;5, 15 males, 9 females), 25 11-year-olds (10;4 – 12;0. *M* = 11;5, 8 males, 19 females) and 57 adults (34 - 54, *M*_= 42, 24 males, 33 females). The age groups that were chosen for participation in this study were based upon Johnson and Wellman's (1982) findings that indicated that school-aged children are in a transitional period regarding their understanding of the mind and brain. Participants were predominantly middle-class and Caucasian, but various ethnic groups were represented.

Materials

Materials consisted of 10 laminated 4x4 inch pictures of people (adult and baby), animals (parrot, cat and fish), intelligent artifacts (robot and computer) and inanimate objects (rock, TV and flower), and two boxes, one marked with the word "can" and the other with the words "can not."

Procedure

The procedure for Study 1 was the same as the pilot study, except that 10 instead of 11 entities were used.

RESULTS

Overview of Analyses and Statistical Procedures. Descriptive statistics, Chi-square, Factor Analysis, and Hierarchical Generalized Linear Models (HGLM) were used to describe and analyze the Study 1 data. The descriptive statistics provide an overall summary of the data, broken down by entity and specific mind/brain-related questions. Chi-square was used to analyze the question regarding whether the mind and brain are considered the same thing or different things. Factor Analysis and HGLM was used to provide insight into differences between entity types regarding mind- and brain-related judgments, as well as to investigate the relationships between the outcome variables (Mind and Brain) and the different attribute types (Emotion, Senses, Sensations, Intentional Behavior, Physical States, Basic Mental Acts, Advanced Mental Acts and Sense of Self). The use of HGLM is an appropriate modeling framework for multilevel data with nonlinear structural models and nonnormally distributed errors (Raudenbush & Bryk, 2002). The data in the present study is nominal-scale, binary repeated measures categorical data, which fits suitably in the HGLM framework.

Table 2. Percentage of participants who claimed that each entity has (or is capable of) each attribute (N=132).

Attribute Type	Attribute	Grown Up	Baby	Parrot	Cat	Fish	Flower	Rock	TV	Robot	Compu-ter
Emotion	**Feel Happy**	99	98	80	87	57	5	0	0	13	2
	Feel Proud	99	82	52	67	33	2	1	1	14	1
Senses	**See things**	100	98	99	98	96	2	0	1	47	6
	Say things	100	87	89	53	14	1	0	25	56	33
Sensations	**Feel Hot**	99	95	89	92	64	30	7	4	13	4
	Feel Hurt	98	99	82	85	64	5	1	2	7	2
Intentional	**Do what it wants**	99	88	84	89	75	5	1	2	17	4
Behavior	**Naughty**	95	83	85	89	39	0	0	2	25	7
Physical	**Go to sleep**	98	99	98	99	82	8	0	11	18	18
States	**Get Sick**	99	100	97	99	96	48	0	7	12	19
Mental	**Think**	99	93	77	81	58	3	1	2	16	7
Acts	**Want**	97	98	92	95	79	15	0	1	17	3
	Remember Yesterday	98	50	52	56	29	1	0	1	30	17
	Remember Phone #	98	16	25	4	5	2	1	5	38	36
	Pretend	98	59	33	30	23	2	1	1	19	2
	Play a Game	98	80	58	70	24	0	0	8	42	35
Sense of Self	**Know Self**	100	44	50	61	48	10	4	5	23	10
	Has a Mind	99	99	92	92	75	4	0	2	12	8
	Has a Brain	100	98	95	95	89	2	0	4	16	14
	Alive	99	100	100	98	98	69	2	2	8	2

Descriptive Statistics. Overall, no significant differences were found for sex or age group (using HGLM). Therefore, data were grouped by entity and attribute. The percentage of participants who claimed that each entity has (or is capable of) each individual attribute (i.e., each question) can be found in Table 2. In sum, participants indicated that grown-ups are capable of everything and rocks are not capable of anything. Babies were judged as capable of most things, but were judged as less capable of certain mental acts (remember yesterday: 50%, remember a phone number: 16%, and pretend: 59%) and knowledge about themselves (i.e., knows it's a baby: 44%). Participants also indicated that the parrot and cat were, overall, slightly less capable than grown-ups in most areas, but particularly less capable in terms of certain mental acts (remember yesterday: 56% & 29%, remember a phone number: 25% & 4%, pretend: 33% & 30%, and play a game: 58% & 70%) and knowledge about themselves (50% & 61%). Fish were judged to be slightly less capable than parrots and cats in all areas. Flowers were judged as incapable of most acts, with the exception of feeling hot (30%) and getting sick (48%), and judged as lacking a mind and brain. Results also indicated that flowers were judged as slightly less likely than animals to be alive. This difference, however, is likely a reflection of most 5-year-olds indicating that a flower is not alive (27% indicated that a flower is alive). The capabilities of TV's were judged as similar to those of rocks, with the exception of the ability to say things (25%). Finally, the robot and computer were judged as having some capabilities in most areas, while lacking a mind and brain, and not being alive.

Robot and Computer Similarity. Chi-square analyses indicated that, overall, the robot and computer were judged similarly (see below), with the exception of the ability to see things, $\chi^2(1, N=264)=58.24$, $p<.001$). These differences in judgment were particularly evident in children (5-year-olds: 77% vs. 4%, 8-year-olds: 83% vs 0%, 11-year-olds: 62% vs 12%, adults: 12% vs 7%).

Mind/Brain Equivalence. A 4 x 2 (age group x mind/brain equivalence) chi-square was used to analyze whether participants indicated that the mind and brain are the same thing or different things. Results found significant age differences, $\chi^2(3, N=97) =$

10.98, p<.01. Further analyses of participants patterns of response indicated that whereas 5-, 8-, and 11-year-olds responded at chance levels, adults were significantly more likely than chance to claim that the mind and brain are different things, $\chi^2(1, N=33) = 18.94$, p<.01.

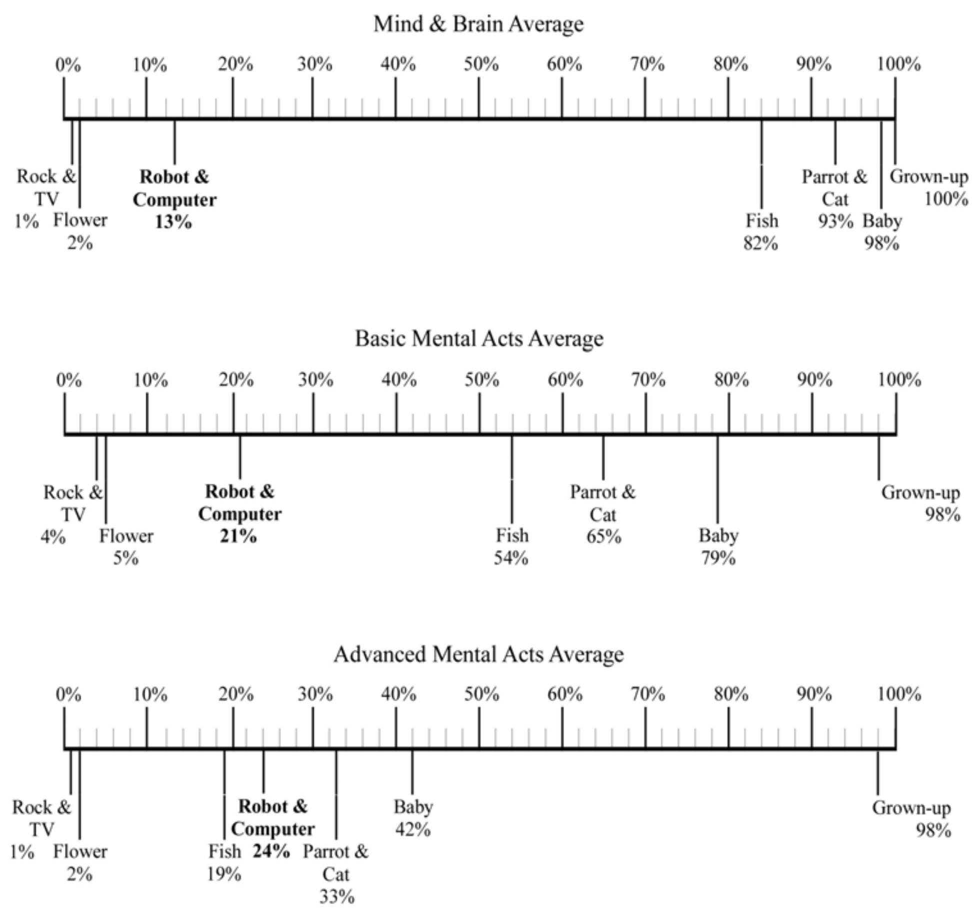
Entities and Ascriptions of a Mind and Brain. The HGLM modeling framework was used to analyze how entities are viewed regarding the presence of a mind and brain. The most informative manner of reporting HGLM results is using Odds Ratios. An odds ratio (OR) indicates whether the probability of a certain event (or in this case, a certain response) is statistically equivalent for two groups. For example, one question could be whether 5-year-olds and 8-year-olds are equally likely to claim that a cat has a mind. In this case, the event is the response indicating whether the cat has a mind, and the two groups are the 5-year-olds and 8-year-olds.An OR of 1 indicates that the probability of an event is equally likely in two groups. An OR significantly greater than or less than 1 indicates that an event is more likely in one of the groups than the other (Pocket dictionary of statistics, 2001).

No significant differences were found for sex, or between entities within each entity type (e.g., between babies and grown-ups). Therefore the data were grouped according to age group and entity type (humans, animals, plants, intelligent artifacts and inanimates), with the presence of a mind and brain as the outcome variables.

Significant differences were found between age groups. Eight- and 11-year-olds were significantly more likely than 5-year-olds to claim overall that entities had a mind (8-year-olds: OR=2.42, p<.05; 11-year-olds: OR=2.39, p<.05) and a brain (8-year-olds: OR=3.42, p<.05; 11-year-olds: OR=3.63, p<.05). Adults were significantly less likely than 5-year-olds to claim that entities had a mind (OR=.39, p<.05). Another way of expressing these findings ((1-OR)*100) is that 8-year-olds are 142% more likely than 5-

year-olds to respond that entities had a mind, and 241% more likely than 5-year-olds to respond that entities had a brain. Eleven-year-olds were found to be 139% more likely than 5-year-olds to respond that entities had a mind, and 263% more likely than 5-year-olds to respond that entities had a brain. Adults were found to be 63% less likely than 5-year-olds to respond that entities had a mind.

Figure 1. The mean percentage of positive responses for the questions regarding the attribution of a mind and brain, the capability to perform mental acts, and the capability to perform advanced mental acts (remember a phone number, remember what happened yesterday, and pretend to be something else) grouped by entity.



A main effect of entity type was found for both the presence of a mind and a brain. For all ages, participants were significantly more likely to attribute the presence of a mind and a brain to humans (Mind: OR=1668.47, $p<.01$; Brain: OR=516.05, $p<.01$), and animals (Mind: OR=3709.83, $p<.01$; Brain: OR=53.72, $p<.01$) than to intelligent artifacts. Results also indicated that participants were significantly less likely to attribute a mind or a brain to plants (Mind: OR=.35, $p<.01$; Brain: OR=.10, $p<.01$) and inanimate objects (Mind: OR=.11, $p<.01$; Brain: OR=.12, $p<.01$) than to intelligent artifacts. An illustration indicating each entity's mean percentage of positive responses for the questions regarding the attribution of a mind and brain can be found in Figure 1. There were no significant interactions found.

Attribute Types and Ascriptions of a Mind and a Brain. Factor analysis and the HGLM modeling framework was used to analyze how attribute types are related to the presence of a mind and brain. The data were averaged and grouped by attribute type, resulting in 7 variables, and subjected to a factor analysis. The factor analysis used the maximum likelihood extraction method and varimax transformation method. After inspection of the eigenvalues and scree plot, a three-factor solution was deemed appropriate. The factor loadings are as follows. Factor 1 included sense of self (factor loading: .735) and emotion (factor loading .735) attribute types, and accounted for 43.5% of the variance. The reliability (internal consistency) was .78. Factor 2 included sensations (factor loading: .760) and physical states (factor loading: .787) attribute types, and accounted for 14.7% of the variance. The reliability (internal consistency) was .78. Factor 3 included the senses (factor loading: .920) attribute type, and accounted for 12.6% of the variance. The reliability (internal consistency) was .78. The resulting factors can be considered as reflecting: (1) more "human-like" capabilities (sense of self and emotion), (2) basic animate characteristics (sensations and physical states), and (3) senses. Results further indicated that the remaining two variables, intentional behavior and mental acts, were complex variables that split across Factor 1 (factor loadings: .456 and.480 respectively) and Factor 3 (factor loadings: .475 and .516 respectively). Complex variables are difficult to interpret, so further analysis of the types of attributes was needed.

Hierarchical Generalized Linear Models (HGLM) was used to further investigate the different attribute types, as well as the relationships between the different attribute types (Emotion, Senses, Sensations, Intentional Behavior, Physical States, Basic Mental Acts, Advanced Mental Acts and Sense of Self) and ascriptions of a mind and a brain. As was mentioned previously, HGLM results are reported using Odds Ratios. Odds Ratios provide the highest level of accuracy for determining the contribution of specific variables within a model. However, to provide a greater understanding of the data, probabilities will also be reported for the percent of variation explained by each model as a whole.

No significant differences were found for sex, age group or between attributes within each attribute type (e.g., feel happy and feel proud for the attribute type emotion) with the exception of mental acts. Recall that the mental acts attribute type included the following attributes: think about something, want something, remember what happened yesterday, remember a phone number, pretend to be something else and play a game. Results indicated that there were significant differences between some, but not all, of the attributes in mental acts. To verify this, the data was subjected to t-tests. Specifically, think about something, want something, and play a game were all found to be significantly different from remember what happened yesterday ($t(131) = 5395$, $p < .01$; $t(131) = 9.87$, $p < .01$; $t(131) = 4.27$, $p < .01$ respectively), remember a phone number ($t(131) = -12.79$, $p < .01$; $t(131) = -20.28$, $p < .01$; $t(131) = -11.86$, $p < .01$ respectively), and pretend to be something else ($t(131) = 11.81$, $p < .01$; $t(131) = 13.78$, $p < .01$; $t(131) = 7.65$, $p < .01$ respectively), but not significantly different from each other. Additionally, remember what happened yesterday, remember a phone number and pretend to be something else were not found to be significantly different from each other. As a result, the mental acts attribute type was split into 2 attribute types, basic mental acts (think about something, want something, and play a game) and advanced mental acts (remember what happened yesterday, remember a phone number, and pretend to be something else) reflecting the patterns of significant and non-significant differences. An illustration indicating each entity's mean percentage of positive responses for the capability to perform basic mental acts and advanced mental acts can be found in Figure 1. Thus, for the remaining analyses, the data were grouped according to attribute type (emotion, senses, sensation, intentional behavior, physical states, basic mental acts, advanced mental acts and sense of self), with the presence of a mind and brain as the outcome variables.

Table 3. Study 1 attribute types most strongly associated with the presence of the mind and brain.

Outcome Variable	Attribute Type Added to Model	Least-Squares Likelihood	Df	P-Value	R^2
Mind	Emotion	-307.02	1	.000	.68
	Physical States	-186.87	2	.000	.81
	Intentional Behavior	-110.80	3	.000	.88
	Adv. Mental Acts	-100.65	4	.000	.90
	Senses	-93.81	5	.000	.90
	Sensations	-88.59	6	.000	.91
Brain	Senses	-414.59	1	.000	.57
	Sensations	-175.09	2	.000	.82
	Physical States	-111.86	3	.000	.88
	Intentional Behavior	-50.57	4	.000	.95
	Basic Mental Acts	-41.66	5	.000	.96
	Advanced Mental Acts	-42.74	6	.000	.96

Note: The related R^2 for each attribute type reflects the amount of variance accounted for by the model when that attribute type is added to the model containing all of the attribute types above it.

The least-squares likelihood values and associated probability (R^2) values for the attribute types predicting the presence of a mind and brain are found in Table 3. Using HLM, a process similar to step-wise forward logistic regression was used to determine the order in which the attribute types were added to the models. With this process, the attribute type that contributed the most predictive power to a model at that particular step was added next. Results indicated that the presence of a mind was found to be most strongly associated with the ability to experience emotion, experience physical states, and engage in intentional behavior, followed by the presence of senses, the ability to engage in advanced mental acts, and the ability to experience sensations. Basic mental acts and a sense of self were not found to contribute significantly to predicting the presence of a mind. This was surprising, particularly for the sense of self. It may be that this result is due to participants primarily associating knowledge of what one is (i.e., the sense of self) only with human adults. A more encompassing sense of self measure may have revealed a stronger association with the mind. The presence of a brain was found to be most strongly associated with the presence of senses, sensations and physical states, followed by the ability to engage in intentional behavior, basic mental acts and advanced mental acts. Emotion and a sense of self were not found to contribute significantly to predicting the presence of a brain.

Table 4. Odds ratios for the Study 1 models that contain attribute types that contribute to predicting the presence of a mind and brain.

Outcome Variable	Model		Odds Ratio*	P-Value
Mind	**Six Attribute Type Model**[1]			
		Emotion	3.77	.000
		Physical States	13.51	.000
		Intentional Behavior	3.74	.000
		Adv. Mental Acts	2.92	.000
		Senses	3.70	.000
		Sensations	2.80	.000
	Three Attribute Type Model[2]			
		Emotion	9.20	.000
		Physical States	16.76	.000
		Intentional Behavior	9.19	.000
Brain	**Six Attribute Type Model**[1]			
		Senses	16.94	.000
		Sensations	4.70	.000
		Physical States	8.28	.000
		Intentional Behavior	3.72	.000
		Basic Mental Acts	2.89	.000
		Advanced Mental Acts	2.17	.000
	Four Attribute Type Model[2]			
		Senses	29.37	.000
		Sensations	5.48	.000
		Physical States	10.29	.000
		Intentional Behavior	5.24	.000

*Note: These models contain (1) all attribute types that contribute to predicting the presence of a mind and brain (6 attribute models) and (2) attribute types that contribute the greatest portion of predictive value towards determining the presence of a mind and brain.

As can be seen in Table 3, ninety-one percent of the variation for predicting the presence of a mind is explained by the full model (i.e., containing all significantly predictive variables). For the brain, 96% of the variation is explained by the full model. However, there are also what can be considered optimal models for predicting the presence of a mind and brain. Eighty-eight percent of the variation for predicting the presence of a mind is explained by the model that contains emotion, physical states and intentional behavior (3 attribute type model). The addition of advanced mental acts, senses and sensations to the 3 attribute type model only explains an additional 1%, 0.5% and 0.5% (respectively) of the variation. Ninety-five percent of the variation for predicting the presence of a brain is explained by the model that contains senses, sensations, physical states and intentional behavior (4 attribute type model). The addition of basic mental acts and advanced mental acts to the 4 attribute model only explain an additional 1% and 0.5% (respectively) of the variation.[2] Odds ratios for each attribute type within these models can be found in Table 4. Recall that odds ratios are more accurate measures of the predictive contribution of each variable within a model than the related R^2 values. The odds ratios for each attribute type depend upon which other attribute types are within the model. In other words, once in the model, the percentage of the variation explained by each attribute type is influenced by which other attribute types are also within the model. This can most clearly be seen by the contribution of physical states to all four models presented in Table 4. While building the models, physical states was found to provide the 2^{nd} and 3^{rd} most predictive capability for the mind and brain, respectively. Once within the models, however, physical states was found to provide the

[2] It should be noted that percentage of the variation explained by each of these attribute types is specific to these models. For example, although the addition of advanced mental states to the 3 attribute model only adds 1% additional predictive capability, this does not mean that the addition of advanced mental states to a different model would also only add 1% additional predictive capability. How much predictive capability will increase with the addition of advanced mental states will depend upon what other variables are already in the model.

most predictive capability for the mind and the 2nd most predictive capability for the brain. Thus, when physical states is being used to predict the presence of a mind and a brain, the relative predictive influence of physical states increases when there are other types of mind and brain related attributes present in the model.

DISCUSSION

The primary goals of Study 1 were to provide insight into: (1) how children and adults conceptualize robots and computers regarding mind- and brain-related capabilities, (2) how children and adults conceptualize the general nature of the mind and its capabilities, and (3) what types of attributes children and adults believe an object or entity must have in order to claim the object or entity has a mind.

Conceptualization of intelligent artifacts. As expected, children and adults view intelligent artifacts as more animate-like than inanimate objects, but not as animate-like as true animate entities. Participants of all ages were more likely to attribute intelligent artifacts with a mind and brain than inanimate objects and plants, but less likely to attribute a mind and a brain to intelligent artifacts than to people or animals. A similar pattern was found with children's and adults' views of the specific attributes of intelligent artifacts. This indicates that people view intelligent artifacts as lying along an animate/inanimate continuum in which they are viewed as neither entirely inanimate objects nor social beings. Further, participants' patterns of responses may indicate that intelligent artifacts are viewed as constituting a category of their own. As can be seen in Figure 1, where intelligent artifacts are situated in relation to other entities depends upon the type of mind- and brain-related questions being asked. When considering the capability to perform advanced mental acts, people cluster intelligent artifacts with animate entities that have limited capabilities in those areas (e.g., fish, parrots and cats). Conversely, when attributing the presence of a mind and brain, and when considering the ability to perform basic mental acts, people view intelligent artifacts as different from all other types of entities. However, the possibility that children and adults view intelligent artifacts as having their own category is not a certainty. Although the relationship between intelligent artifacts and other types of animate and inanimate entities varies depending upon the type of questions being asked, it is the capability level of certain animates and not intelligent artifacts that varies. It could be argued that in order to conclude that intelligent artifacts are truly viewed as their own category, the capability levels of intelligent artifacts will need to vary from both animate and inanimate entities, depending upon the questions being asked.

Previous studies have considered the possibility that children attribute mind- and brain-related behavior to entities based upon anthropomorphic similarity to humans (Schaife & van Duuren, 1995; van Duuren & Schaife, 1996; Johnson, 1990). The results of the present study provide some support for this position. Referring again to Figure 1, when attributing a mind and brain to various entities, and considering the ability to perform basic mental acts, a response pattern emerges that can be construed as signifying that these capabilities are influenced by anthropomorphic similarity. Thus, the rock, which has the least similarity to humans, is consistently at the lower end of the continuum, while grown-up humans are at the highest end. The other entities are ordered from lesser to increasing anthropomorphic similarity to humans. This finding is consistent with previous studies (Schaife & van Duuren, 1995; van Duuren & Schaife, 1996; Johnson, 1990). However, the data from the present study show that anthropomorphic similarity is not the only influence on children's attributions of mind- and brain-related behavior. The third scale in Figure 1, depicting perceived capability to perform advanced mental acts, indicates that when determining whether an entity can engage in advanced mental acts, people cluster intelligent artifacts with animate entities (particularly animals). If anthropomorphic similarity was being used to make this judgment, then the intelligent artifacts would be judged as different from and below the capabilities of animals. Further, robots and computers were judged as similar to each other across all types of attributes. If anthropomorphic similarity determines how different entities are judged, then overall, robots' capabilities should have been judged as different from and greater than computers. This indicates that people are not always using anthropomorphic similarity in the judgments of various entities.

General conceptualization of the mind and brain. Adults specified that the mind and brain are "different things." This indicates that by adulthood, people make a clear distinction between the mind and brain, paralleling the dualistic philosophical position regarding the nature of the mind. Children's responses, on the other hand, did not show a clear pattern. Children of all ages responded to this question randomly. Although it could be argued that this indicates that children do not distinguish between the mind and brain, there is a more likely explanation. Previous research has found that older children do distinguish between the mind and brain (Johnson, 1990). This inconsistency between the previous findings and the findings of the present study may be due to methodological factors. The question regarding whether the mind and brain are the same or different things was always asked at the end of the experimental session. At this point, children had already been asked many questions regarding mind- and brain-like capabilities. To better hold their attention, children were often told that the session was almost finished and that they were going to receive a prize for participating. In their excitement, children may simply have responded randomly because they wanted to end the session quickly and get their prize.

Children and adults also differed in their overall willingness to attribute a mind and brain to various entities. Consistent with previous studies, 5-year-olds were less willing than older children to claim that entities had a brain. This is consistent with previous studies' findings that 5-year-olds are more stringent in their attribution of a brain (Scaife & van Duuren, 1995; van Duuren & Scaife, 1996). A similar pattern was found when attributing a mind, with one exception. Adults were less likely than children of all ages to claim that entities had a mind. This is an indication that adults view the mind as different from the brain, and, further that, unlike the brain, adults are more stringent than children in their attributions of a mind. This may reflect a view that the mind is more exclusive to biological, animate entities than the brain.

Attributes of the mind and brain. Consistent with previous studies, the mind and brain were found to have overlapping capabilities. Results indicated that physical states, intentional behavior, senses, sensations and advanced mental acts are all predictive of the presence of a mind and a brain. Emotion was found to be predictive of the presence of a mind, and basic mental acts were found to be predictive of the presence of a brain. Although a number of attributes were found to be predictive of both a mind and a brain, differences were found regarding which types of attributes are most important for each. The presence of a brain was found to be most strongly associated with the ability to experience senses, sensations and physical states, followed by the ability to engage in intentional behavior, perform basic mental acts and perform advanced mental acts. The presence of a mind was found to be most strongly associated with the ability to experience emotion, experience physical states, and engage in intentional behavior, followed by the ability to perform advanced mental acts, experience senses, and experience sensations. These findings are consistent with Johnson and Wellman's (1982) findings. Senses, sensations and physical states were found to account for 88% of the variation for predicting the presence of a brain. As with Johnson and Wellman's first study, this indicates that the brain is more strongly associated with bodily functions than the mind. Emotion, physical states, intentional behavior and advanced mental acts were found to account for 90% of the variation for predicting the presence of a mind. With the exception of the possible influence of physical states (see below), this can be interpreted as indicating that the mind is more strongly associated with more wholly mental acts than the brain. This also is consistent with Johnson and Wellman's findings.

There is, however, one apparent inconsistency between the present study's findings, and Johnson and Wellman's (1982) findings. In the Johnson and Wellman study, emotion was found to be characteristic of both the presence of a mind and a brain. In the present study, although emotion was found to be highly predictive of the presence of a mind, it was not found to be predictive of a brain. One explanation for the apparent discrepancy between these two sets of findings is that the present study included a larger number of attributes. As a result, emotion did not emerge as a strong predictor for the presence of the brain relative to these other attributes. Thus, although it may in fact be important if included in a smaller set of attributes, its role is not as strong when other predictors are available.

The ability to experience physical states was found to be highly predictive of a mind and a brain. However, the importance of physical states in predicting the presence of a mind and a brain needs to be interpreted with caution. First, one must consider the influence of the types of entities used in the present study. The particular physical states used, "go to sleep" and "get sick," are attributes that are very strongly related to living, animate entities. As can be seen in Table 2, there is very little variation in attributions of these physical states to people and animals. The pattern of physical states responses parallels a pattern of animate/inanimate entities (i.e., people and animals are animate entities and received high scores on physical state responses; similarly, rocks and TVs are inanimate entities and received low scores on physical states responses). As it is primarily people and animals that are accredited with having a mind and a brain, it is difficult to determine whether the predictive strength of physical states found in the present study is due to the relationship between physical states and entity type, or between physical states and the mind, and physical states and the brain. Second, there is also a question of how these physical states were being interpreted by the participants. It can be argued that participants may have interpreted "go to sleep" and "get sick" not as physical states, but instead as variations of mental states. For example, when a person "go[es] to sleep," there is a change in that person's mental state. A person goes from being awake and attentive, to a state where certain types of mental activity, such as dreams, can take place. Due to these issues, a definitive determination regarding the influence of physical states on the presence of the mind and brain cannot be made at this time. Instead, a more cautionary interpretation is appropriate, asserting that the present study provides support for the position that physical states are related to the presence of a mind and a brain, but that further studies are needed to fully understand the nature of this relationship.

Study 1 used intelligent artifacts to help determine the relation between various attributes and the presence of a mind. Although this can provide substantial information, it may not be sufficient to completely reveal understanding of the relation between these attributes and mind. By using objects and entities that are familiar to the participants, assumptions and information that the participants generally associate with these objects and entities likely affect their responses. Thus, to provide additional information about the relation between attributes and the presence of a mind, a second study introduced nonexistent entities which were not familiar to the participants. A similar methodology was used by Richards and Siegler (1986) to investigate children's and adults' understanding of attributions of life.

Pilot Study 2

METHOD

Participants

Twenty-eight children, 12 younger children (5;0-7;0, *M*=5;9) and 16 older children (8;0-11;10, M=9;5), and 26 adults (30-53, M=41) participated in the pilot study. Participants were predominantly middle-class and Caucasian, but various ethnic groups were represented.

Materials

Materials consisted of 12 laminated 8.5x2 inch pieces of paper with 3 phrases written on them, 12 4x4 inch pieces of paper with nonsense words on them and 1 8.5x2 inch piece of paper with “Yes”, “No” and “Can’t Tell” written on it.

Procedure

Children were interviewed individually at the Children's Research Lab. They were told that they were going to play a game involving a character who, while on a field trip, encountered 12 entities he (or she, if the participant was female) knew nothing about. It was explained that while on this field trip, the character took notes about each of the entities he or she encountered, and that the character was really interested in figuring out whether each of the entities had a mind or brain. Children were told that, for each entity, they would be presented with the character’s notes both auditorally and visually (using text), and asked a number of questions. It was further explained to them that for each question, they could answer “yes,” “no,” or “can’t tell.” These response options were also presented both auditorally and visually (using text).

Prior to the test scenarios, children were presented with two warm-up tasks. In the first task, children were told that the character encountered a rock and a grown-up man. They were then asked whether the entity "has a brain" (for one entity) and "has a mind" (for the other entity). Children were corrected if they answered incorrectly. Pairing of the mind and brain questions with the rock and man was counterbalanced between subjects. In the second warm-up task, children were told (and shown) that the character's notes indicated that a "Morp likes to touch things with its fingertips, it doesn't have any legs and it's sometimes noisy." Children were then asked three questions: (1) Do you think a Morp has fingers? (correct answer: yes), (2) Do you think a Morp has a tail? (correct answer: can't tell), and (3) Do you think a Morp has knees? (correct answer: no). Following children's response to the third question, children were also asked "How can you tell a Morp doesn't have knees?" Children's responses were corrected if they answered incorrectly. The purpose of these warm-up tasks was to familiarize children with the interview format and to establish that positive, negative and uncertain responses were valued.

Following the warm-up tasks, children were presented with 12 test scenarios. In each test scenario, children were verbally and visually (with text) presented with the nonsense name of the entities encountered and three of the entity's characteristics. The purpose of this study was to determine which three of four attributes (emotion, desire, cognition and self-controlled interaction) had the strongest relation with the presence of a mind. Because of the limited attention span of young children, only a limited number of attributes could be investigated. Three attributes was the maximum number that could be used and we wanted to select the three most relevant attributes.

Table 5. Attribute combinations used in Pilot Study 2.

		NEITHER DESIRE NOR COGNITION	DESIRE	COGNITION
EMOTION YES	**Interaction Yes**	Emotion + Interaction	Desire + Emotion + Interaction	Cognition + Emotion + Interaction
	Interaction No Info	Emotion	Desire + Emotion	Cognition + Emotion:
EMOTION NO INFO	**Interaction Yes**	Interaction	Desire + Interaction	Cognition + Interaction
	Interaction No Info	Ø	Desire	Cognition

For eleven of the scenarios, the entity was described as having a combination of the following capabilities: (1) emotion (happy/glad), (2) cognition (think/pretend), (3) desire (want) and (4) self-controlled interaction (playing with other [entities]/working with other [entities]). Three of these capabilities (emotion, cognition, and self-controlled interaction/volition) were chosen because they have been found to be important to related areas of research (e.g., attributions of a brain and life). Desire was included to ascertain whether a simpler mental state might be as influential as emotion, cognition and volition. A sample scenario might involve the character encountering a Bink that shows emotion (is happy), has cognitive capabilities (thinks) and interacts with other Binks (plays with). In another test scenario, the character encounters a Jutling which exhibits emotion, is white and medium-sized. Finally, in one of the scenarios (i.e., ø), the entity only exhibited ambiguous characteristics (white, brown or black; tall, medium-sized or short; weighs a lot or doesn't weigh very much)(see Table 5).

For each scenario, children were asked memory check questions (designed to ensure that children remembered the entity's three characteristics) and the following 5 test questions: (1) Do you think a [entity] has a heart?, (2) Do you think a [entity] is alive?, (3) Do you think a [entity] has a brain?, and (4) Do you think a [entity] has a mind? Questions 3 and 4 were counterbalanced between scenarios. The protocol and scripts used for the pilot study can be found in Appendix C.

Pilot Data Results and Conclusions

To determine which attributes should be included in the main study, scores were calculated as follows: (1) a score for each scenario in which the entity possessed a particular attribute (emotion, desire, cognition and interaction) was summed for the mind and the brain questions (yielding 8 scores), and (2) a score for each scenario in which an entity lacked a particular attribute (no emotion, no desire, no cognition and no interaction) was calculated for the mind and brain questions (yielding 8 additional scores). For example, for emotion, one score for mind-emotion was calculated by summing the "Do you think a [entity] has a mind?" test questions for all scenarios in which the entity was described as being capable of experiencing emotion. A second similar score was calculated for not emotion by summing the "Do you think a [entity] has a mind?" test questions for all scenarios in which the entity was not described as being capable of experiencing emotion. Similarly, one score for brain-desire was calculated by summing the "Do you think a [entity] has a brain?" test questions for all scenarios in which the entity was described as being capable of experiencing desire, and one was calculated for no desire. See Table 6 for the mean scores for each of these variables.

Table 6. Children's mean scores in Pilot Study 2 for the presence of a mind and brain for each attribute

Attribute	**Mind**	**Brain**
Cognition - Yes	3.44*[1]	3.52[1]
Cognition – No Info	3.09*[1]	3.33[1]
Desire - Yes	3.87[1]	3.70[1]
Desire – No Info	3.58[1]	3.74[1]
Emotion - Yes	5.52*[2]	5.57*[2]
Emotion – No Info	4.44*[2]	4.92*[2]
Interaction - Yes	5.60*[2]	5.72[2]
Interaction – No Info	4.89*[2]	5.43[2]

* significantly different from its corresponding mind or brain score
Note 1: out of 4
Note 2: out of 6

Four one-way ANOVAs (attribute: present, absent) were conducted for each attribute type. Significant differences were found for the presence of a mind for cognition ($F(1,21)=11.88$, $p=.002$), emotion ($F(1,21)=15.04$, $p=.001$) and interaction ($F(1,21)=12.79$, $p=.002$), and for the presence of a brain for emotion ($F(1,21)=9.52$, $p=.006$). Significant differences were not found between desire and no desire scenarios for either the mind or brain. As a result, desire was eliminated from the main study.

Table 7. Children's mean scores in Pilot Study 2 for the presence of a mind

Attribute	Younger Children	Older Children
Cognition - Yes	2.78[1]	3.81[1]
Cognition – No Info	2.19[1]	3.57[1]
Desire - Yes	3.25[1]	4.20[1]
Desire – No Info	2.83[1]	4.00[1]
Emotion - Yes	4.38[2]	5.13[2]
Emotion – No Info	3.44[2]	5.00[2]
Interaction - Yes	4.78[2]	5.06[2]
Interaction – No Info	3.38[2]	5.70[2]

Note 1: out of 4
Note 2: out of 6

Main effects of age were also found for determination of the presence of a mind for cognition ($F(1,21)=7.26$, $p<.01$), emotion ($F(1,21)=7.49$, $p<.01$), desire ($F(1,21)=5.92$, $p<.05$) and interaction ($F(1,21)=7.49$, $p<.01$). Mean scores can be found in Table 7. These results are consistent with previous studies which have found that older children are more flexible than younger children in attributing more human-like characteristics to various types of entities (Nigam & Klahr, 1999; Scaife & van Duuren, 1995; van Duuren & Scaife, 1996).

Suggested Changes

A number of changes for Study 2 were implemented. First, questions about desire were eliminated. This allowed the inclusion of the entities with ambiguous and inanimate characteristics (see below). In the pilot study, only one of the twelve scenarios did not involve an attribute that was believed to be associated with the mind. This may have caused children to be more likely to claim that everything had a mind. By limiting the number of attributes used, thereby allowing the inclusion of more scenarios in which the entity does not have a characteristic commonly associated with the mind, Study 2 has a more balanced and cleaner methodology. This makes it easier to detect, and possibly eliminate, any response biases that may be present.

The second change was to eliminate the memory check questions for each entity's characteristics. This was done primarily to shorten the study, as children tended to lose attention toward the end. In the pilot study, children of all ages were able to answer the memory check questions without any difficulty. In addition, this information is available to the children in written form during the entire scenario and question period. In fact, a number of children pointed out the availability of the answers to the experimenter when asked the memory check questions.

The third change involved shortening the introduction to the study. In the pilot study, children tended to get fidgety and bored during the introduction. As a result, they did not seem to retain some of what they were told during the introduction.

Study 2

METHOD

Participants

Participants were 75 children, 29 5-year-olds (5;0 – 5;11, *M* = 5;7, 13 males, 16 females), 24 8-year-olds (7;11 – 8;11, *M* = 8;5, 9 males, 15 females) and 21 11-year-olds(11;0 – 11;11, *M* = 11;5, 8 males, 13 females). The age groups that were chosen for participation in this study were based upon Johnson and Wellman's (1982) findings that indicated that school-aged children are in a transitional period regarding their understanding of the mind and brain. Participants were predominantly middle-class and Caucasian, but various ethnic groups were represented.

Materials

Materials consisted of 12 laminated 8.5x2 inch pieces of paper with 3 phrases written on them, 12 4x4 inch pieces of paper with nonsense words on them and 1 8.5x2 inch piece of paper with "Yes", "No" and "Can't Tell" written on it, 12 pieces of paper with images of a boy in various backgrounds, and 12 pieces of paper with images of a girl in various backgrounds.

Table 8. Test scenario-attribute combinations used in Study 2.

		COGNITION		
		NO INFO	**YES**	AMBIGUOUS OR INANIMATE
EMOTION YES	**Interaction Yes**	Emotion + Interaction	Cognition + Emotion + Interaction	*Ambiguous*
	Interaction No Info	Emotion	Cognition + Emotion:	*Ambiguous*
EMOTION NO INFO	**Interaction Yes**	Interaction	Cognition + Interaction	*Inanimate*
	Interaction No Info	*Ambiguous*	Cognition	*Inanimate*

Procedure

The protocol for Study 2 was the same as that for the 2nd pilot study with a few exceptions. First, questions about desire were eliminated, allowing the inclusion of entities with ambiguous and inanimate characteristics. Thus, the 12 test scenarios for Study 2 were as follows. For seven of the scenarios, the entity was described as having a combination of the following capabilities: (1) emotion (happy/glad), (2) cognition (think/pretend), and (3) self-controlled interaction (playing with other [entities]/working with other [entities]). In three of the scenarios, the entity only exhibited ambiguous characteristics (white, brown or black; tall, medium-sized or short; weighs a lot or doesn't weigh very much). These were included to determine whether children have a bias towards attributing a mind when they lack any relevant information. In two additional scenarios, the entity exhibited one of two blatantly inanimate properties (made of metal/made of plastic). These were included as a control against *yes* response bias, as children should clearly respond *no* to these questions. The 12 combinations of capabilities for the 12 test scenarios used in Study 2 can be found in Table 8. The presentation order of the scenarios was randomized between subjects. The two other changes from the 2nd pilot study were: (1) the memory check questions for each test scenario were eliminated, and (2) the introduction to the study was significantly shortened.

RESULTS

Hierarchical Generalized Linear Models (HGLM) were used to analyze the Study 2 data. The use of HGLM is an appropriate modeling framework for multilevel data with nonlinear structural models and nonnormally distributed errors (Raudenbush & Bryk, 2002). The data in the present study is nominal-scale, multinomial categorical data, which fits suitably in the HGLM framework. Recall that the most informative manner of reporting HGLM results is using Odds Ratios. An odds ratio (OR) indicates whether the probability of a certain event (or in our case, a certain response) is statistically equivalent for two groups. An OR of 1 indicates that the probability of an event is equally likely in two groups. An OR significantly greater than or less than 1 indicates that an event is more likely in one of the groups than the other (Pocket dictionary of statistics, 2001).

No significant differences were found for sex. Therefore the data were grouped according to age group and scenario type (Inanimate, Ambiguous, CEI (cognition, emotion and interaction), CE (cognition and emotion), CI (cognition and interaction), C (cognition), EI (emotion and interaction), E (emotion) and I (interaction) (see Table 8)), with the presence of a mind and brain as the outcome variables. Three additional scenario types were created (using dummy variables) to determine whether the number of variables alone would yield significantly different responses. These additional scenarios were: (1) OneVar, which included responses to the cognition (C), emotion (E) and interaction (I) scenarios, (2) TwoVar, which included the cognition and emotion (CE), cognition and interaction (CI), and emotion and interaction (EI) scenarios, and (3) ThreeVar, which only included the cognition, emotion and interaction (CEI) scenarios. The purpose of using these additional scenario types was to determine whether children were sensitive to merely the number of relevant attributes within the scenarios versus the specific attributes themselves.

Table 9. Significant odds ratios for the Study 2 scenario comparisons predicting the presence of a Brain.

Scenario Comparisons		**Odds Ratio**	**P-Value**
Cognition & Emotion vs.	Emotion	.17	<.01
	Cognition	.26	<.05
	Interaction	.20	<.01
Cognition & Interaction vs.	Emotion	.25	<.01
	Interaction	.30	<.01
	Cognition	.39	.07
Cognition, Emotion & Interaction vs.	Emotion	.21	<.01
	Cognition	.25	<.05
	Interaction	.02	<.01
	Emotion & Interaction	.46	.07
Inanimate vs.	OneVar	.02	<.01
	TwoVar	.01	<.01
	ThreeVar	.004	<.01
Ambiguous vs.	OneVar	.12	<.01
	TwoVar	.04	<.01
	ThreeVar	.04	<.01
OneVar vs.	TwoVar	2.89	<.01
	ThreeVar	3.82	<.01

Attributions of a Brain. Significant differences were found between scenario type. As was previously stated, the original scenario types used in this study were as follows: Inanimate, Ambiguous, CEI (cognition, emotion and interaction), CE (cognition and emotion), CI (cognition and interaction), C (cognition), EI (emotion and interaction), E (emotion) and I (interaction) (see Table 8). Results indicated that children were significantly less likely to attribute a brain to an entity in the Inanimate scenario than all of the other original scenarios, and in the Ambiguous scenario than all other original scenarios (all $p<.01$). Further, children were significantly more likely to attribute a brain to an entity in the CE scenario than the E, C, and I scenarios, the CI scenario than the E and I scenarios, and the CEI scenario than the E, C, and I scenarios. Finally, there were trends toward children being more likely to attribute a brain to an entity in the CEI scenario than the EI scenario, and the CI than the C scenario (see Table 9 for odds ratios and p-values).

Results also indicated that children were significantly less likely to attribute a brain to an entity in the Inanimate scenario than in the OneVar, TwoVar, or ThreeVar scenarios. Children were also significantly less likely to attribute a brain to an entity in the Ambiguous scenario than in the OneVar, TwoVar, or ThreeVar scenarios. Finally, children were significantly less likely to attribute a brain to an entity in the OneVar than in the TwoVar or ThreeVar scenarios (see Table 9 for odds ratios and p-values).

Table 10. Odds ratios for the Study 2 response comparisons (“Can’t Tell” vs. [Response]) predicting the presence of a mind and brain.

Attribute	Age Comparisons		Response	Odds Ratio	P-Value
Brain	**5-year-olds vs.**	**8-year-olds**	Yes	7.33	<.01
			No	.17	<.01
		11-year-olds	Yes	4.97	<.01
			No	.22	<.01
Mind	**5-year-olds vs.**	**8-year-olds**	Yes	2.89	<.05
			No	.38	<.05
		11-year-olds	Yes	3.34	<.01
			No	.25	<.01

Significant differences were found between age groups regarding the use of “can’t tell” as a response to questions, but not regarding “yes” and “no” responses. When determining whether an entity had a brain, 5-year-olds were significantly less likely than 8- and 11-year-olds to respond to questions using “can’t tell” (see Table 10). Another way of expressing these findings ((1-OR)*100) is that 8-year-olds are 634% more likely than 5-year-olds to respond that they "can't tell" whether something has a brain when those responses are compared to their "yes" responses, and 83% more likely to respond that they "can't tell" whether an entity has a brain when those responses are compared to their "no" responses. Eleven-year-olds are 90% more likely than 5-year-olds to respond that they "can't tell" whether something has a brain when those responses are compared to their "yes" responses, and 78% more likely to respond that they "can't tell" whether an entity has a brain when those responses are compared to their "no" responses. Means and standard deviations of the attributes can be found in Table 11.

Table 11. Means and standard deviations for Study 2 attributes.

Attribute	**Mind***	**Brain***
Cognition[1]	3.74(0.98)	3.85(1.12)
Emotion[1]	3.86(1.26)	3.88(1.20)
Interaction[1]	3.92(1.27)	3.79(1.28)
Ambiguous[2]	3.13(1.83)	3.12(1.86)
Inanimate[3]	0.44(0.75)	0.51(0.88)
OneVar[2]	2.92(1.12)	2.84(1.15)
TwoVar[2]	2.91(0.88)	2.88(0.88)
ThreeVar[4]	0.93(0.41)	0.97(0.37)

* Keep in mind that because the data is categorical, means are not used in the analyses.
Note 1: out of 8
Note 2: out of 6
Note 3: out of 4
Note 4: out of 2

Attributions of a Mind. Results indicated that children were significantly less likely to attribute a mind to an entity in the Inanimate scenario than all of the other original scenarios, and in the Ambiguous scenario than all other original scenarios (all $p<.01$). Further, children were significantly more likely to attribute a mind to an entity in the CE scenario than the E, the CI scenario than the E and I scenarios, and the CEI scenario than the E and I scenarios. Finally, there were trends towards children being more likely to attribute a mind to an entity in the CE scenario than the I and EI scenarios, and the CI than the EI scenario (see Table 12 for odds ratios and p-values).

Table 12. Significant odds ratios for the Study 2 scenario comparisons predicting the presence of a mind.

Scenario Comparisons		**Odds Ratio**	**P-Value**
Cognition & Emotion vs.	Emotion	.25	<.01
	Interaction	.38	.07
	Emotion & Interaction	.46	.08
Cognition & Interaction vs.	Emotion	.21	<.05
	Interaction	.13	<.01
	Emotion & Interaction	.29	.07
Cognition, Emotion & Interaction vs.	Emotion	.32	<.05
	Interaction	.20	<.01
Inanimate vs.	OneVar	.02	<.01
	TwoVar	.14	<.01
	ThreeVar	.01	<.01
Ambiguous vs.	OneVar	.02	<.01
	TwoVar	.01	<.01
	ThreeVar	.01	<.01
OneVar vs.	TwoVar	.49	<.01
	ThreeVar	.38	<.05

Results also indicated that children were significantly less likely to attribute a mind to an entity in the Inanimate scenario than the OneVar, TwoVar, or ThreeVar scenarios. Children were also significantly less likely to attribute a mind to an entity in the Ambiguous scenario than OneVar, TwoVar, or ThreeVar scenarios. Finally, children were significantly less likely to attribute a mind to an entity in the OneVar than the TwoVar or ThreeVar scenarios (see Table 12 for odds ratios and p-values).

Significant age differences were also found in the determination of the presence of the mind. Five-year-olds were significantly less likely than 8- and 11-year-olds to respond to questions using "can't tell" (see Table 10). Another way of expressing these findings is that 8-year-olds are 189% more likely than 5-year-olds to respond that they "can't tell" whether something has a mind when those responses are compared to their "yes" responses, and 62% more likely to respond that they "can't tell" whether an entity has a mind when those responses are compared to their "no" responses. Eleven-year-olds are 247% more likely than 5-year-olds to respond that they "can't tell" whether something has a mind when those responses are compared to their "yes" responses, and 75% more likely to respond that they "can't tell" whether an entity has a mind when those responses are compared to their "no" responses. Means and standard deviations of the attributes can be found in Table 11.

DISCUSSION

Children of all ages clearly differentiated between various types of scenarios. The following discussion is structured around five main questions of interest: (1) Are children more likely to ascribe a mind or brain to an entity for which they lack any relevant information about that entity as compared to an entity that exhibits clearly inanimate characteristics?, (2) Are children more likely to ascribe a mind or brain to an entity that exhibits cognitive, emotional or interactive capabilities than a clearly inanimate entity or an entity for which they lack any relevant information?, (3) When considering the role of cognition, emotion and interaction in attributing a mind or brain to an entity, do children consider the presence of one of those characteristics more important than the others?, (4) Are children more likely to ascribe a mind or brain to an entity as the number of mind/brain-related capabilities the entity exhibits increases?, and (5) When the number of mind/brain-related capabilities that an entity exhibits does increase, do children's ascriptions of the presence of a mind or brain depend upon whether the added capability is cognition, emotion or interaction?

When children were unfamiliar with an entity and lacked knowledge of that entity's mind/brain-related capabilities (i.e., the entity's description only contained ambiguous characteristics such as white and medium sized), children were more likely to claim that the entity had a mind and brain than when an entity exhibited clearly inanimate characteristics (e.g., made of plastic). This indicates that when children lack relevant mind/brain-related information about an unknown entity, they do not automatically assume that the entity is inanimate and does not have a mind or brain. Instead, they seem to take a stance that is consistent with the belief that this unknown entity might possibly have a mind or brain. This stance, however, is not equivalent to assuming that an unknown entity does in fact have a mind or brain. Children were more likely to claim that an entity exhibiting basic cognition, emotion or interaction capabilities (i.e., the entity was described as having one mind/brain-related capability) had a mind and brain than that an entity for which they lacked relevant knowledge had a mind and brain (i.e., the entity's description only contained ambiguous characteristics), . Thus, it seems that whereas children believe that unfamiliar inanimate entities do not have a mind or brain, and unfamiliar entities which exhibit mind/brain-related capabilities are more likely to have a mind and brain, children seem to take a more moderate 'just-in-case' attitude towards unfamiliar entities which only exhibit ambiguous characteristics.

Children do seem to consider cognition, emotion and interaction as indicators of the presence of a mind and brain. However, although children do seem to believe that each of these capabilities alone makes it more likely that an entity has a mind and brain, children do not seem to believe that any one of these three capabilities is more indicative of the presence of a mind and brain. Children were equally likely to claim that an unfamiliar entity had a mind and brain when that entity exhibited cognition, emotion or interaction. There is also some evidence that children may believe that as the number of mind/brain-related capabilities an entity exhibits increases, the probability that the entity has a mind and brain also increases. Children were more likely to claim that an unfamiliar entity had a mind and brain when that entity exhibited two or three mind/brain-related capabilities than when the entity only exhibited one mind/brain-related capability (e.g., cognition and emotion vs. emotion alone).

Older children (8- and 11-year-olds) in this study were more likely to claim that they were not provided sufficient information to determine whether the mind and brain were present (i.e., responding "can't tell:") than were younger children (5-year-olds). This can be interpreted in one of three ways. First, it may be, as previous studies have indicated, that 5-year-olds are more inflexible when it comes to attributing a brain or brain-related capabilities (and in our case, a mind) than older children. Younger children simply may not be as willing as older children to consider that an entity might have human-like characteristics unless they are more certain of that entity's similarity to humans. Alternately, it may be that 5-year-olds are less willing to respond that they "can't tell" whether they have sufficient information to make a decision due to issues of cognitive complexity. It may be more difficult for 5-year-olds than older children to reason about having a lack of sufficient information to make a decision regardless of the context. Although the 2nd warm-up task presented to children attempted to reduce the probability that this issue would be problematic, it may be that the use of one warm-up task to address this was not sufficient. Finally, it may be that 5-year-olds are less knowledgeable about the mind and brain than older children, limiting their ability to determine when they do not have sufficient information to make this decision. If this is the case, then 5-year-olds' criteria to determine whether something has a mind or brain may be simpler than older children's criteria to make this decision. As a result, 5-year-olds may require less information than older children to make this determination, making it less likely that they will respond that they do not have sufficient information.

GENERAL DISCUSSION

The present studies investigated what types of attributes children and adults believe an object or entity must have in order to claim that the object or entity has a mind. This provides insight into children's and adults' generalized conception of the mind, including beliefs about what the mind is, what it can do, and what sort of entities have minds. Results indicate that children and adults have multifaceted beliefs about the mind, and that, although there is some overlap, these beliefs differ from those about the brain. Further, beliefs about the mind develop over time, with different aspects of these beliefs developing at different times. Finally, the results provide evidence that the importance of attributes associated with determining whether something has a mind varies depending upon the specific type of entity or mind-related attribute being investigated.

Previous research has often treated the presence of mental state capabilities, such as thinking, as synonymous with having a mind. However, children's and adults' beliefs about the mind are much more complicated than this "thinking = mind" equation. The current studies have found that although mental state capabilities are an important aspect of children's and adults' beliefs about the mind, the presence of mental state capabilities alone are not necessarily synonymous with having a mind. Both Study 1 and Study 2 show that in addition to cognitive acts, emotion and volition (e.g., intentional behavior) are predictive of the presence of a mind. Further, Study 1 found that physical states, senses and sensations are also important predictive factors. Importantly, Study 1 provided evidence that the complexity of the particular type of attribute being used to reason about the mind is also significant. Recall from Study 1 that advanced mental acts, but not basic mental acts, were predictive of the presence of a mind. Although not assessed for in the present studies, it is likely that this difference in complexity is also significant for the predictive power of other types of attributes. Finally, the relative level of predictive importance for various types of attributes depends upon which other attributes are present in the situation. In Study 1, for example, emotion was found to be the most predictive of the presence of a mind. How much predictive value emotion had in determining the presence of a mind, however, depended upon which other attributes were also being considered. Thus, when emotion, physical states and intentional behavior were present in the model, the predictive value of emotion was greater than when emotion, physical states, intentional behavior, advance mental acts, senses and sensations were all present (see Table 4).

In sum, this indicates that children and adults do not use a simple formula for determining whether something does or does not have a mind. There appears to be specific types of attributes that are predictive of having a mind, but how predictive each type of attribute is depends upon the specific situation being reasoned about. Thus, we can conclude that cognition, emotion, volition, physical states, senses and sensations are all predictors of the presence of a mind, but which type of attribute is most predictive depends upon the context of the situation (i.e., what other types of attributes are present).

Quite often, researchers have discussed the mind and brain as if they are interchangeable. Consistent with Johnson and Wellman's (1982) findings, the current findings indicate that this may not be appropriate. Johnson & Wellman found that although there is overlap between children's beliefs about the mind and brain, children consider the mind and brain as separate entities. Further, they found that children associate the mind and brain most strongly with different types of attributes. Although both the mind and brain were associated with mental and emotional acts, the brain was found to be most strongly associated with bodily acts, whereas the mind was more associated with mental acts. The present studies' findings are consistent with this. The results indicated that children and adults believe that the mind and brain have overlapping capabilities. In both Study 1 and Study 2, children and adults associated both the mind and brain with cognitive and volitional acts. Children in Study 2 also associated both the mind and brain with emotion. Even so, children's and adults' beliefs about the mind and brain were found to be different in some ways. In Study 1, when attributes related to bodily acts (i.e., senses and sensations) were included, the types of attributes most predictive of the presence of a brain were those that can be considered bodily acts. This was not the case when determining the presence of a mind. Even with the inclusion of attributes related to bodily acts, the types of attributes most predictive of the presence of a mind were those that can be considered more "mental" (i.e., emotion, volition, and advanced mental acts). This tells us that children and adults do consider the mind and brain as related, but still different from each other.

An important aspect of children's and adults' beliefs about the mind is determining how these beliefs develop and change over time. Previous studies that have investigated children's beliefs about the mind (Johnson & Wellman, 1982) and brain (Johnson & Wellman, 1982; Scaife & van Duuren, 1995; van Duuren & Scaife, 1996; Johnson, 1990; Gottfried et al., 1999) have provided evidence that school-aged children are in a transitional period in which their beliefs about the mind and brain are still developing. The current studies provide support for this position. In both Study 1 and Study 2, 5-year-olds' patterns of responses were found to be different from those of older children and adults in attributing the presence of a mind and brain. In previous studies, young children were consistently found to be less likely than older children and adults to attribute human-like characteristics to different types of entities (Nigam & Klahr, 1999; Scaife & van Duuren, 1995; van Duuren & Scaife, 1996). Similar to these previous studies, 5-year-olds in Study 1 and Study 2 were less likely than older children to attribute a brain to an entity. Five-year-olds' in Study 2 were also found to be less likely to attribute a mind to an entity than were older children. It appears from these findings that development involves becoming more likely to attribute a mind and brain to various entities as one gets older. However, adults in Study 1 were found to be less likely than children to attribute a mind to different entities. This indicates that, with regard to attributing a mind, additional changes take place between age 11 and adulthood, possibly with children older than 11 and adults viewing the mind as more uniquely human than the brain. Further, this may be linked to a greater differentiation between the mind and brain in adults.

Finally, the results provide evidence that the importance of attributes associated with determining whether something has a mind varies depending upon the specific type of entity or mind-related attribute being investigated. Some researchers have suggested that children, and sometimes adults, use anthropomorphic similarity to humans when making attributions of mental capabilities (Carey, 1985; Inagaki & Hatano, 1987; Inagaki & Hatano, 1999; Inagaki & Sugiyama, 1988; Montgomery, 1994). As can be seen in Figure 1, the current findings do not entirely support this conclusion. A pattern of response similar to judgments based on anthropomorphic similarity can be seen for certain types of attributions, such as determining the presence of a mind or brain. However, for other types of attributions, such the ability to perform advanced mental acts, the pattern of response is markedly dissimilar from a pattern based on anthropomorphic similarity. If it was the case that people were basing their judgments of mental capabilities entirely on anthropomorphic similarity, then these disparate patterns of responses would not exist, and attributions of all types of mental capabilities would have the same pattern of responses. More specifically, if children and adults were truly using anthropomorphic similarity on which to base their judgments, the advanced mental capabilities would reflect the same anthropomorphic pattern, as advanced mental capabilities are more human-like than are basic mental capabilities. Thus, it seems unlikely that children or adults are basing their judgments of mental capabilities on anthropomorphic similarities.

The current studies expand our knowledge regarding children's and adults' theory of mind. Nevertheless, further studies into children's and adults' beliefs about the mind are necessary as there are still many unanswered questions. For example, further studies looking at basic versus advanced levels of the various types of attributes are needed. The current studies provide evidence that advanced mental acts are more strongly associated with the mind than the brain. It may be that the same pattern holds true for other types of attributes, such as volition or emotion. Another question of interest that should be pursued concerns the potential effect of technology on children's and adults' beliefs about the nature of the mind. It may be that, as Turkle (1984, 1991, 1998, 2000a, 200b) suggested, technological advances and more exposure to technology will change people's beliefs about the nature of the mind. For example, longitudinal studies should be undertaken investigating children's and adults' generalized beliefs about the mind in relation to the types of technology they encounter on a regular basis. In addition, other possible influences regarding whether or not children and adults will attribute a mind to an entity should be investigated. For example, the effect of different physical characteristics of the entities should be investigated. It may be, for example, that people will be more likely to attribute a mind to unknown entities that exhibit physical characteristics of animates such as soft, curved lines, as opposed to those typically found in inanimates such as straight, sharp lines (Johnson, Booth & O'Hearn, 2001). Finally, an important area of future research is to investigate the actually direction and reasoning process that children and adults engage in when thinking about the presence of a mind and brain, and the presence of related attributes. Although the current findings investigate the relationship between various types of attributes and the presence of the mind and brain, the exact process or direction of children's and adults' reasoning about these issues is not explored. Research into these and other issues will lead to a greater understanding of children's and adults' beliefs about the mind, and how those beliefs are shaped by the world around us.

Appendix A.

Pilot Study 1 protocol.

General Questions

1. Where is your foot? Foot Other: ______________

What kinds of things can you do with your foot?

2. Where is your heart? Chest Other: ______________

What kinds of things can your heart do?

3. Where is your brain? Head Other: ______________

What kinds of things can you do with your brain?

If I opened up your head, would I be able to see or touch your brain? Yes No

4. Where is your mind? Head Other: ______________

What kinds of things can you do with your mind?

If I opened up your head, would I be able to see or touch your mind? Yes No

Sorting Task 1

Now I'm going to ask you about what different kinds of people, animals and things can do. I have some cards with pictures on them. I need to make sure you know what each picture is before we start, so when I show you each picture, just tell me what it is…[show each picture and ask what each is: grown-up, kid, baby, parrot, cat, fish, flower, rock, TV, robot and computer]

I'm going to ask you which ones can do certain things. What you'll do is put those that can do what I ask you about in this box (CAN box) and those that can not do what I ask you about in this box (CAN NOT box).

Let's practice one. I'll do a few first, and then you can do some. My first question is: "Which ones can walk all by themselves?"

Let’s see, grown-ups can walk all by themselves, so I’ll put the grown-up in the CAN box.

Rocks can’t walk all by themselves, so I’ll put the rock in the CAN NOT box.

Now you try it [hand the child the kid, cat, fish and flower picture]—prompt & correct if needed

Great! Let’s get started.

[For each Q, mix the order of the cards and hand them to the child. On the response form, circle the items placed in the can box]

Which ones can *Feel Happy*?
Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Feel Proud*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *See Things*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Say Things*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

You know how when you walk into a hot room you *feel hot*?
Which ones can *Feel Hot*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Feel Hurt If They Fall on the Floor*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Do Something Just Because They Want To*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Sometimes Be Naughty*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Go To Sleep*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Get Sick*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Self-Knowledge Questions

Now I'm going to ask you about what each of these know about.

Here's a **grown-up**. Do grown-ups know that they are grown-ups?	Yes	No
Here's a **kid**. Do kids know that they are kids?	Yes	No
Here's a **baby**. Do babies know that they are babies?	Yes	No
Here's a **parrot**. Do parrots know that they are parrots?	Yes	No
Here's a **cat**. Do cats know that they are cats?	Yes	No
Here's a **fish**. Do fish know that they are fish?	Yes	No
Here's a **flower**. Do flowers know that they are flowers?	Yes	No
Here's a **rock**. Do rocks know that they are rocks?	Yes	No
Here's a **TV**. Do TVs know that they are TVs?	Yes	No
Here's a **robot**. Do robots know that they are robots?	Yes	No
Here's a **computer**. Do computers know that they are computers?	Yes	No

Sorting Task 2

I just have a few more questions about what different kinds of people, animals and things can do. Just like before, we're going to use the CAN and CAN NOT boxes. Remember, what you'll do is put those that **can** do what I ask you about in this box (CAN box) and those that **can not** do what I ask you about in this box (CAN NOT box).

Which ones can *Think about Something*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Play a Game*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Remember a Phone Number*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Remember What Happened Yesterday*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Want Something*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones can *Pretend to Be Something Else*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones *Are Alive*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones *Have A Brain*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Which ones *Have A Mind*?

Grown-up **K**id **B**aby **P**arrot **C**at **Fi**sh **Fl**ower **R**ock **TV** **R**obot **C**omputer

Is the mind and brain the *same* thing or *different* things? Same Different

Appendix B.

Pilot Study 1 parent questionnaire.

Instructions: Please answer the following as accurately as possible. Keep in mind that there are no right or wrong answers.

Child's Experience

Does your child have access to a personal computer? ☐ Yes ☐ No
(for example, a PC or Mac)

If **yes**,

In which is this computer located? ☐ Home ☐ School ☐ Other

(select all that apply)

Overall, how often does your child use the computer?
☐ Multiple times a day ☐ Once a day ☐ Every 2-3 days ☐ Once a week ☐ 2-3 times a month ☐ Once a month ☐ Rarely/ Never

What does your child use the computer for? (select all that apply)
☐ Schoolwork/ Homework ☐ Play Games ☐ Web Browsing ☐ E-mail/ Chatting ☐ Other: __________

Of the above, which does your child spend the most time doing on the computer?
☐ Schoolwork/ Homework ☐ Play Games ☐ Web Browsing ☐ E-mail/ Chatting ☐ Other: __________

Has your child ever taken a computer class? ☐ Yes ☐ No
If yes, what type of class(es)?

____

Does your child own any "intelligent" electronic toys such as furbies or robots? ☐ Yes ☐ No
(i.e., toys that can learn new things, are programmable, etc.)
If **yes**,
What "intelligent" electronic toys does your child own? __________________________
How long has your child had this toy(s)? ___________
Overall, how often does your child play with this toy?
☐ Multiple times a day ☐ Once a day ☐ Every 2-3 days ☐ Once a week ☐ 2-3 times a month ☐ Once a month ☐ Rarely/ Never

Do you think your child believes this toy is alive? ☐ Yes ☐ No
If yes, please list some examples of why you believe this:

Does your child interact with this intelligent toy differently from the way they interact with other toys? ☐ Yes ☐ No

If yes, please list some examples of how:

<u>Parent's Computer Experience</u>
Do you have access to a computer? ☐ Yes ☐ No
If **yes**,
In which is this computer located? ☐ Home ☐ School ☐ Other___________
(select all that apply)

What type of Internet connection do you have?
☐ Dial-up ☐ DSL ☐ Cable Modem (RoadRunner) ☐ Other: ___________

Overall, how often do you use a computer?
☐ Multiple times a day ☐ Once a day ☐ Every 2-3 days ☐ Once a week ☐ 2-3 times a month ☐ Once a month ☐ Rarely/ Never

What do you use a computer for? (select all that apply)
☐ Work-related activities ☐ Household/ Financial ☐ Play Games ☐ Web Browsing ☐ E-mail/ Chatting ☐ Other: ___________

Of the above, which do you spend the most time doing on the computer?
☐ Work-related activities ☐ Household/ Financial ☐ Play Games ☐ Web Browsing ☐ E-mail/ Chatting ☐ Other: ___________

What is your proficiency with computers?
☐ Beginner ☐ Intermediate ☐ Advanced ☐ Expert/Professional (e.g., Programmer)

<u>Your spouse/partner/other older household member's computer experience:</u>
Does another older individual in your household have access to a computer?
☐ Yes ☐ No
If **yes**,
Who is this other household member (e.g., spouse, sibling, etc.)?

____
In which is this computer located? ☐ Home ☐ School ☐ Other: ___________
Overall, how often does your other older household member use a computer?
☐ Multiple ☐ Once a ☐ Every ☐ Once ☐ 2-3 times ☐ Once a ☐ Rarely/

times a day	day	2-3 days	a week	a month	month	Never

What does your other older household member use a computer for? (select all that apply)

☐ Work-related activities ☐ Household/ Financial ☐ Play Games ☐ Web Browsing ☐ E-mail/ Chatting ☐ Other: __________

Of the above, which does your other older household member spend the most time doing on the computer?

☐ Work-related activities ☐ Household/ Financial ☐ Play Games ☐ Web Browsing ☐ E-mail/ Chatting ☐ Other: __________

What is your other older household member's proficiency with computers?

☐ Beginner ☐ Intermediate ☐ Advanced ☐ Expert/Professional (e.g., Programmer)

Attributions:

Which ones can *Feel Happy*?

☐ **G**rown-up ☐ **K**id ☐ **B**aby ☐ **P**arrot ☐ **C**at ☐ **Fi**sh ☐ **Fl**ower ☐ **R**ock ☐ **TV** ☐ **R**obot ☐ **C**omputer

Which ones can *Feel Proud*?

☐ **G**rown-up ☐ **K**id ☐ **B**aby ☐ **P**arrot ☐ **C**at ☐ **Fi**sh ☐ **Fl**ower ☐ **R**ock ☐ **TV** ☐ **R**obot ☐ **C**omputer

Which ones can *See Things*?

☐ **G**rown-up ☐ **K**id ☐ **B**aby ☐ **P**arrot ☐ **C**at ☐ **Fi**sh ☐ **Fl**ower ☐ **R**ock ☐ **TV** ☐ **R**obot ☐ **C**omputer

Which ones can *Say Things*?

☐ **G**rown-up ☐ **K**id ☐ **B**aby ☐ **P**arrot ☐ **C**at ☐ **Fi**sh ☐ **Fl**ower ☐ **R**ock ☐ **TV** ☐ **R**obot ☐ **C**omputer

You know how when you walk into a hot room you *feel hot*?
Which ones can *Feel Hot*?

☐ **G**rown-up ☐ **K**id ☐ **B**aby ☐ **P**arrot ☐ **C**at ☐ **Fi**sh ☐ **Fl**ower ☐ **R**ock ☐ **TV** ☐ **R**obot ☐ **C**omputer

Which ones can *Feel Hurt If They Fall on the Floor*?

☐ **G**rown-up ☐ **K**id ☐ **B**aby ☐ **P**arrot ☐ **C**at ☐ **Fi**sh ☐ **Fl**ower ☐ **R**ock ☐ **TV** ☐ **R**obot ☐ **C**omputer

Which ones can *Do Something Just Because They Want To*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Sometimes Be Naughty*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Go To Sleep*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Get Sick*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Think about Something*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Play a Game*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Remember a Phone Number*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Remember What Happened Yesterday*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Want Something*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones can *Pretend to Be Something Else*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones *Are Alive*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones *Have A Brain*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

Which ones *Have A Mind*?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grown-up	**K**id	**B**aby	**P**arrot	**C**at	**Fi**sh	**Fl**ower	**R**ock	**TV**	**R**obot	**C**omputer

<u>Self-Knowledge Questions</u>

Do **grown-ups** know that they are grown-ups?	☐ Yes	☐ No
Do **kids** know that they are kids?	☐ Yes	☐ No
Do **babies** know that they are babies?	☐ Yes	☐ No
Do **parrots** know that they are parrots?	☐ Yes	☐ No
Do **cats** know that they are cats?	☐ Yes	☐ No
Do **fish** know that they are fish?	☐ Yes	☐ No
Do **flowers** know that they are flowers?	☐ Yes	☐ No
Do **rocks** know that they are rocks?	☐ Yes	☐ No
Do **TVs** know that they are TVs?	☐ Yes	☐ No
Do **robots** know that they are robots?	☐ Yes	☐ No
Do **computers** know that they are computers?	☐ Yes	☐ No

Is the mind and brain the *same* thing or *different* things? Same
Different

Appendix C.

<u>Study 2 protocol.</u>

Today, we're going to play a game. In this game, there's a boy named Alex who loves going new places and learning new things. For our game today, we're going to talk about a fieldtrip that Alex went on. While he was on his trip, he took notes about all sorts of people, animals and things that he'd never seen before. What he was *really* interested in was *figuring out* whether the new things he saw had a *mind* or a *brain*. Let me show you what I mean.

Note: Each child is only asked about either the rock or the grown-up man.

Alex saw a **rock**. Let me ask you…

Would Alex say that a rock has a brain?	Yes	**No**
[That's right/Actually], a rock *does not* have a brain.		
Would Alex say that a rock has a mind?	Yes	**No**
[That's right/Actually], a rock *does not* have a mind.		

Alex also saw a **grown-up man**.

Would Alex say that a grown-up man has a mind?	**Yes**	No
[That's right/Actually], a grown-up man *does* have a mind.		
Would Alex say that a grown-up man has a brain?	**Yes**	No
[That's right/Actually], a grown-up man *does* have a brain.		

Great! Let me show you how the game works. What I want to do is read you Alex's notes about the new people, animals and things that he saw and see if *you* can *figure out* which ones have a *mind* or a *brain*. The tricky part of the game is that I don't have all of Alex's notes. Some of them got lost. So sometimes you'll know enough to figure it out, but sometimes you won't. And that's Ok, just tell me that you can't tell.

You can answer my questions by saying **Yes**, **No** or that you **Can't Tell** (*point to yes, no and can't tell on strip*). I want you to think *really hard* about what I tell you and the questions I ask you because sometimes, after you answer my question, I'll ask you *why* you think that's the answer. That doesn't mean your answer is right or wrong, I just want to know what you think. Let's try one so you can see what I mean.

[*get Morp card*] We'll start with a Morp. Alex's notes say that a Morp likes to touch things with its fingertips, it doesn't have any legs and it's sometimes noisy. So, tell me…

Do you think a Morp *has fingers*?	**Yes**	No	Can't Tell

[That's right/Actually], a Morp *does* have fingers.
Do you think a Morp *has a tail*? Yes No **Can't Tell**
[That's right/Actually], we *can't tell* whether a Morp has a tail.
Do you think a Morp *has knees*? Yes **No** Can't Tell
[That's right/Actually], a Morp *does not* have knees.
What makes you think that? How can you *tell* a Morp *doesn't* have knees?
[That's right/Actually], we can tell a Morp *doesn't* have knees because a Morp *doesn't* have any legs.

Ok great! Let's get started. Now remember, your job is to try to figure out which ones have a *mind* or a *brain*.

[*All the cards with the entity's names should be randomized. Write down the name of the entity for each question and use it in the blank areas. The attribute statements should be read as if you are reading Alex's notes.*]

1. Here's a ______. Alex's notes say that _______s think about lots of things, they can feel happy and they often play with other ________s.
Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Do _______s *never* think about anything or do they think about lots of things?
b. Can _______s feel happy or do they *never* feel happy?
c. Do _______s *always* play alone or do they often play with other _______s?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell
e. Do you think a _______ *is alive*? Yes No Can't Tell
f. Do you think a _______ *has a mind*? Yes No Can't Tell
g. Do you think a _______ *has a brain*? Yes No Can't Tell
h. If you had to guess, would you say a _______ is *probably* a person, an animal or a thing? Person Animal Thing

2. Here's a ______. Alex's notes say that _______s often play with other ________s, they want lots of things and they can feel happy.
Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Do _______s *always* play alone or do they often play with other _______s?
b. Do _______s want lots of things or do they *never* want anything?
c. Can _______s feel happy or do they *never* feel happy?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell
e. Do you think a _______ *is alive*? Yes No Can't Tell
f. Do you think a _______ *has a brain*? Yes No Can't Tell
g. Do you think a _______ *has a mind*? Yes No Can't Tell
h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

3. Here's a ______. Alex's notes say that _______s are tall, they often play with other ________s and they can feel happy.
Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Are _______s short or are they tall?
b. Do _______s *always* play alone or do they often play with other _______s?
c. Can _______s feel happy or do they *never* feel happy?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell
e. Do you think a _______ *is alive*? Yes No Can't Tell

Remember I told you that after some of my questions, I would ask you why you think that's the answer? I'm going to do that after my next 3 questions. Remember, that doesn't mean that your answers are right or wrong. I just want to know what you're thinking. Ok? So, tell me…

---

f. Do you think a _______ *has a mind*? Yes No Can't Tell
What makes you think that? ____
(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)
g. Do you think a _______ *has a brain*? Yes No Can't Tell
What makes you think that? ____
(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

What makes you think that? ____________________________________

(*How can you tell its probably a…*)

4. Here's a ______. Alex's notes say that _______s can feel happy, they are heavy and they think about lots of things.

Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Can _______s feel happy or do they *never* feel happy?

b. Are _______s heavy or are they light?

c. Do _______s *never* think about anything or do they think about lots of things?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

f. Do you think a _______ *has a brain*? Yes No Can't Tell

g. Do you think a _______ *has a mind*? Yes No Can't Tell

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

5. Here's a ______. Alex's notes say that _______s want lots of things, they can feel happy and they are white.

Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Do _______s want lots of things or do they *never* want anything?

b. Can _______s feel happy or do they *never* feel happy?

c. Are _______s red or are they white?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

f. Do you think a _______ *has a mind*? Yes No Can't Tell

g. Do you think a _______ *has a brain*? Yes No Can't Tell

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

6. Here's a ______. Alex's notes say that _______s can feel happy, they are often outside and they are medium sized.

Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Can _______s feel happy or do they *never* feel happy?

b. Are _______s *always* inside or are they often outside?

c. Are _______s really small or are they medium-sized?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

Just like before, after my next 3 questions, I'm going to ask you why you think that's the answer? Remember, that doesn't mean that your answers are right or wrong. I just want to know what you're thinking. Ok? So, tell me…

---

f. Do you think a _______ *has a brain*? Yes No Can't Tell

What makes you think that?

____

(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

g. Do you think a _______ *has a mind*? Yes No Can't Tell

What makes you think that?

____

(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

What makes you think that?

____

(*How can you tell its probably a…*)

7. Here's a ______. Alex's notes say that _______s often play with other ________s, they think about lots of things and they are medium sized.

Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Do _______s *always* play alone or do they often play with other _______s?

b. Do _______s *never* think about anything or do they think about lots of things?

c. Are _______s really small or are they medium-sized?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

f. Do you think a _______ *has a mind*? Yes No Can't Tell

g. Do you think a _______ *has a brain*? Yes No Can't Tell

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

8. Here's a ______. Alex's notes say that _______s want lots of things, they are brown and they often play with other ________s.
Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Do _______s want lots of things or do they *never* want anything?

b. Are _______s brown or are they green?

c. Do _______s *always* play alone or do they often play with other _______s?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

f. Do you think a _______ *has a brain*? Yes No Can't Tell

g. Do you think a _______ *has a mind*? Yes No Can't Tell

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

9. Here's a ______. Alex's notes say that _______s are heavy, they often play with other ________s and they are often outside.
Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Are _______s heavy or are they light?

b. Do _______s *always* play alone or do they often play with other _______s?

c. Are _______s *always* inside or are they often outside?

Test Questions: So, tell me…

d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

Just like before, after my next 3 questions, I'm going to ask you why you think that's the answer? Remember, that doesn't mean that your answers are right or wrong. I just want to know what you're thinking. Ok? So, tell me…

f. Do you think a _______ *has a mind*? Yes No Can't Tell

What makes you think that? ___________________________________

(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

g. Do you think a _______ *has a brain*? Yes No Can't Tell

What makes you think that? ___________________________________

(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

What makes you think that? ___________________________________

(*How can you tell its probably a…*)

10. Here's a ______. Alex's notes say that _______s think about lots of things, they are white and they are tall.

Let me check to make sure you remember Alex's notes.

Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]

a. Do _______s *never* think about anything or do they think about lots of things?

b. Are _______s red or are they white?

c. Are _______s short or are they tall?

Test Questions: So, tell me…
d. Do you think a _______ *has a heart*? Yes No Can't Tell
e. Do you think a _______ *is alive*? Yes No Can't Tell
f. Do you think a _______ *has a brain*? Yes No Can't Tell
g. Do you think a _______ *has a mind*? Yes No Can't Tell
h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

11. Here's a ______. Alex's notes say that _______s want lots of things, they are heavy and they are often outside.
Let me check to make sure you remember Alex's notes.
Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]
a. Do _______s want lots of things or do they *never* want anything?
b. Are _______s heavy or are they light?
c. Are _______s *always* inside or are they often outside?
Test Questions: So, tell me…
d. Do you think a _______ *has a heart*? Yes No Can't Tell
e. Do you think a _______ *is alive*? Yes No Can't Tell
f. Do you think a _______ *has a mind*? Yes No Can't Tell
g. Do you think a _______ *has a brain*? Yes No Can't Tell
h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

12. Here's a ______. Alex's notes say that _______s are medium sized, they are brown and they are tall.
Let me check to make sure you remember Alex's notes.
Memory Check Questions: [*After each question, state the correct answer: That's right/Actually…*]
a. Are _______s really small or are they medium-sized?
b. Are _______s brown or are they green?
c. Are _______s short or are they tall?
Test Questions: So, tell me…
d. Do you think a _______ *has a heart*? Yes No Can't Tell

e. Do you think a _______ *is alive*? Yes No Can't Tell

_____

Just like before, after my next 3 questions, I'm going to ask you why you think that's the answer? Remember, that doesn't mean that your answers are right or wrong. I just want to know what you're thinking. Ok? So, tell me…

f. Do you think a _______ *has a brain*? Yes No Can't Tell

What makes you think that? ______________________________________

(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

g. Do you think a _______ *has a mind*? Yes No Can't Tell

What makes you think that? ______________________________________

(*How can you tell a ____ [has/doesn't have]…/Why can't you tell…*)

h. If you had to guess, would you say a _______ is probably a person, animal or thing? Person Animal Thing

What makes you think that? ______________________________________

(*How can you tell its probably a…*)

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Vita

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